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ABSTRACT

This publication is designed to provide interested teachers with teaching activities for all grade levels and subject areas that can be used to help students learn about water resources. For each activity, the purpose, level, subject, and concept are given. Activities are organized by grade level. Most of these water related learning activities are science (77) or social studies (46) activities with several mathematics, art, language arts, and music activities included. In general, the activities involve the students in investigations to answer given questions designed to stimulate student thought on water use and management. A section is also included that contains lists of films, filmstrips, addresses of film distributors, and water testing equipment and manufacturer's addresses. (MR)

WATER-RELATED TEACHING ACTIVITIES

Selected and Developed by

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Charles L. Price is presently a Graduate Research Associate at the ERIC Center and is nearing completion of a Ph.D. in Science Education at The Ohio State University. His interests include research design and analysis, as well as the integration of K-12 science education curricula.

ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for this series are invited.

John F. Disinger
Associate Director
Environmental Education

Sponsored by the Educational Resources Information Center of the National Institute of Education and The Ohio State University.

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INTRODUCTION

It is difficult to exaggerate the importance of water. All plant and animal life is dependent on this natural resource which, until recent times, has been plentiful, pure, and relatively inexpensive in most areas of the United States. The tremendous growth of population, agriculture, industrial production, and commerce in the U.S.A. during our 200-year history has been linked closely to ample water supplies and waterways.

But evidence indicates that water is not as plentiful or pure as it used to be. Water rationing in the San Francisco area, truck farmers in Southern California complaining about reductions in their irrigation allotments, and city dwellers in many parts of the United States being asked or ordered to curtail lawn sprinkling, provide evidence of growing shortages unimagined a few short years ago. Similarly, the massive fish kills, warnings regarding eating fish contaminated by mercury compounds, and research data indicating the presence of carcinogenic substances in some city water supplies provides evidence of serious decline in the quality of water supplies.

Problems associated with water are world-wide. Droughts in India or Africa evolve into international programs to relieve the sufferings of the millions affected by such events. Cholera, a disease feared for centuries, continues to appear whenever water supplies become contaminated.

Most American school children know little about the importance of water in producing our food, clothing, shelter, other necessities, and the luxuries of life. Many city children know little more about water than it comes from a tap. They are, for the most part, unaware of the source of their water supply or of the myriad problems associated with providing their families and cities with pure and adequate amounts of this life-sustaining substance. City children are, typically, quite ignorant about the amount of water needed to produce the food so readily available in supermarkets. Rural as well as city children are unaware of the vast amounts of water used in industries such as steel, chemicals, paper manufacturing, and electrical power generation.

Population growth coupled with industrial growth has resulted in increasing pressure on the world's fresh water supplies. It is surprising to learn that more than 99% of the world's water is unusable for many purposes because it is in the salty oceans or locked up in ice sheets or glaciers. Less than one-tenth of one percent of the world's water is found in stream channels and fresh-water lakes. This life-sustaining fraction is being subjected to increasing stress; this fraction is the center of mounting concern from many groups.

Conflicting demands for limited water supplies will undoubtedly escalate in coming years. Water taken from the Columbia River to irrigate orchards cannot be used to power turbines it would have to run through. Water taken from the Colorado River to irrigate orange groves in Southern California cannot be used in the homes of Los Angeles. Water used in Colorado to operate a proposed coal-slurry pipeline would not be available for agriculture. Building dams to increase city water supplies or to control floods meets with violent opposition from farmers whose land is inundated by such development. Requiring industries such as steel manufacturing to meet higher water quality standards

may raise prices to the point where they are not competitive in the world market. Conflicts such as these may result in more rather than less governmental intervention. And conflicts about water supplies and water quality standards are already evident between various levels of state government, between states, and between countries.

It is to these concerns that this activity booklet is addressed. We believe that knowledge about water--its physical and chemical properties, conservation and pollution abatement, the interrelatedness of water to all aspects of the environment, and the decision-making processes involved in water-related environmental concerns are all important topics for study in our schools. Furthermore, we believe the topics to be interdisciplinary in nature and believe they are most effectively taught as such.

This resource booklet contains in excess of 100 activities. Activities have been categorized according to grade level, but slight modification of an activity would often make it suitable for another age group. The activities are also deemed suitable for use by teachers in several subject matter areas.

Many of the activities have been developed from materials found in the library of the ERIC Center for Science, Mathematics, and Environmental Education; materials produced by individuals, groups of teachers or others who believe that students should be examining more carefully the importance of water in our way of life.

WATER-RELATED CONCEPTS*

1. Water has unique physical and chemical properties.

2. Water is essential to all human, animal, and plant life.

3. Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

4. Water is not unlimited; therefore, wise water management is essential to our continued social progress.

5. Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

6. Water has recreational, aesthetic, cultural, and inspirational values which contribute to the quality of human life.

7. There are limits to what water management can do to control the availability and quality of water.

8. In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

9. The ultimate goal of water management should be to promote the highest and best quality of life for eveyone.

10. There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

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*Adapted from a framework developed by the Western Regional Environmental Education Council, July 1976.

BREAKDOWN OF ACTIVITIES BY CATEGORY

(Some activities fall into more than one subject area category)

	Category	Number of Activities
Grade Level:	Elementary	28
	Elementary-junior high school	14
	Elementary-junior-senior high school	10
	Junior high school	12
	Junior-senior high school	28
	Senior high school	10
Subject Area:	Science	77
	Mathematics	15
	Social Studies	46
	Art	11
	Language Arts	7
	Music	1

TABLE OF CONTENTS

WATER-RELATED

TEACHING ACTIVITIES

PURPOSE: To demonstrate the water cycle and the concepts of evaporation and condensation.

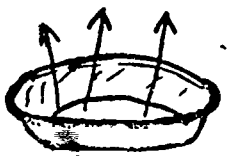
LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

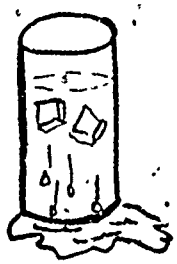
ACTIVITY: Boil some water in a beaker or teakettle. Ask the students to explain where the water went. Why can't we see it now? Can we ever see water in the air? (Yes, clouds) Introduce the concept of a water cycle--i.e., that water does not escape the earth's atmosphere but is simply converted back and forth from liquid and gaseous states.

Can water get into the atmosphere without being heated to boiling? Some may know the concept of evaporation. Place some water in a pie pan and allow it to stand overnight. See if students can explain what happens.



Where does the water go?

Place ice and water in a glass. After a few minutes water will appear on the glass. Where does the water come from? Place warm water in another glass. Why doesn't water form on the glass? If your students cannot provide the answers, explain that it is due to condensation. The topic of dew on grass may come up.



From where does the water come?

PURPOSE: To observe the tendency of plant roots to seek water.

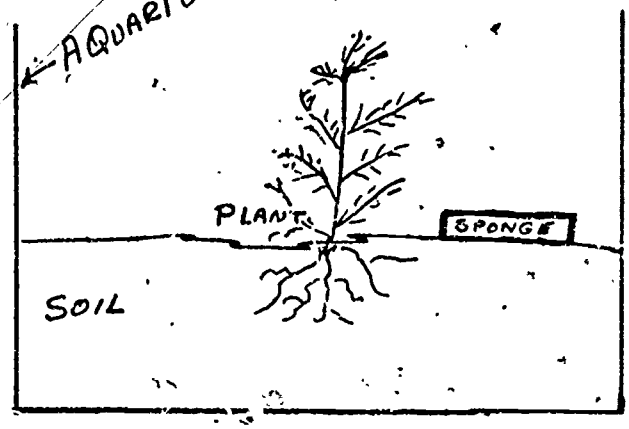
LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water is essential to all human, animal, and plant life.

ACTIVITY: Plant a well-rooted flower or vegetable plant at the very edge of a small aquarium so that one side of the root structure can be clearly seen. Do not water the plant on all sides, but rather place a good sized sponge 4-6 inches from the stem of the plant and water regularly only the sponge.

Have the children make daily observations of the visible plant roots. How many days passed before the roots moved toward the wet soil under the sponge? Did the roots move up, laterally, down, or all three ways? What happened to the roots on the dry side of the plant?



PURPOSE: To show that the boiling point of water can be changed by adding substances to it.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties

The addition of many substances such as sugar or salt raises the boiling point of water. This is made apparent by the sudden decrease in bubbles of water after the substance has been added to boiling water. When the solution has absorbed more heat, then boiling will resume.

Pure water boils at 100°C. (212°F.) at sea level. When another substance is added to water, the combination is no longer just water, but a solution. Salt water, for example, has a higher boiling point than does fresh water.

ACTIVITY: Place two small beakers of water on a hot plate. When the water boils, add several teasponns of salt to one beaker. What happens? Add several teaspoons of sugar to the other beaker. Does the boiling stop? Why?

What effect does salt and sugar have on the boiling temperature of water? Test this hypothesis with a thermometer.

PURPOSE: To show that water expands when it freezes.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

When water freezes, the molecules arrange themselves in such a way that the crystals formed are about 1/9 larger in volume than the volume of water from which they originated. Water confined in a flexible container may bulge the walls of the container when it freezes. If water is in a rigid container, the expansion which occurs upon freezing often breaks the container.

ACTIVITY: Fill a jar with water and screw the lid on tightly. Place the jar in a plastic bag and set it in the freezer overnight. Remove the bag containing the jar. What happened to the jar? Why?

You may want to repeat the experiment with a milk carton filled with water. When water freezes in the milk carton, why doesn't it break?

PURPOSE: To introduce the concept of water pollution.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 1. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 216

ACTIVITY: Introduce the concept of pollution by holding up a glass of clean water and a glass of water which has had a few drops of oil and sweepings from the floor added. Ask the children to describe the clean and polluted glasses of water. Engage the children in making a list of substances which can pollute water. Are all pollutants (materials which cause pollution) visible?

It is obvious that many types of water pollution make water unattractive. What are some of the other effects of water pollution? Certain types of pollutants (plant life and decaying material) may use up most of the supply of oxygen in the water. What effect may this have on desirable species of plants and animals (fish)?

Ask the children to bring in photographs from magazines and newspapers which show polluted and clean bodies of water. These could be combined into a bulletin board or display of some sort.

PURPOSE: To demonstrate the erosive effect of moving water.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Rockcastle, Verne N. Water Wonders. Cornell Science Leaflet, v61, n1, 1967..

ACTIVITY: Break off, with a hammer, several small pieces from an old soft brick and put them in a gallon clear plastic container with a screw top. Fill the container half full of tap water and screw the top on securely.

Pass the container around the classroom, letting each child shake it ten times before passing it on to the next pupil. After each 100 shakes ask the class to examine the contents and record the changes that have occurred. Consider questions such as the following: What happens to the color of the water? What, if anything, happens to the shape of the pieces of brick? If you shook the container long enough, what would be the result? When hard pebbles are rolled over each other on a beach or in a stream bottom, what happens to them?

The children may enjoy making a room collection of rocks that have been shaped and smoothed by action of moving water.

PURPOSE: To illustrate how ground cover prevents splash erosion caused by rain.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Teaching Soil and Water Conservation: A Classroom and Field Guide. U.S. Department of Agriculture, Soil Conservation Service. PA-341.

Falling water displaces soil when it hits the ground. This can be shown dramatically by placing some small coins or small flat stones on bare soil and then, with use of a sprinkling can, sprinkle water from a height of four or five feet on the coins and soil. Soil will be splashed or washed away, except for that directly beneath the coins or small stones. Anything that breaks the force of falling water will reduce its erosive effect on soil.

ACTIVITY: Punch holes in two fruit jar lids and place them upside down over two pint jars. Fill each lid level full with the same kind of soil. Cover one lid with a layer of grass clippings while leaving the other one bare. Sprinkle each lid with the same amount of water from the same height and for the same time. Note what happens to the soil in each lid. Note, also, the color and amount of water that soaks through into each jar. Would it be a good idea to place grass clippings on a garden?

PURPOSE: To show that erosion can be reduced by careful soil preparation and management.

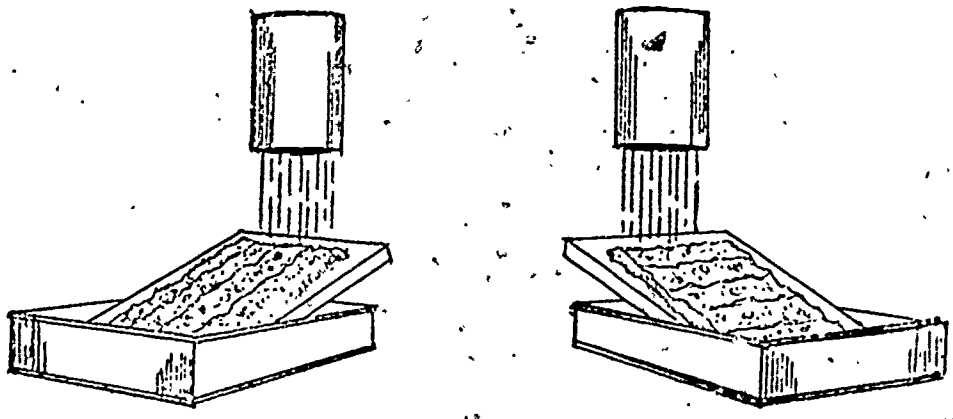
LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Science: Grades K-6. State Department of Public Instruction, Raleigh, North Carolina, Publication No. 410, 1968. ERIC: ED 022 078

ACTIVITY: Build two models as shown. Elevate the boards in the pan at an angle of about 30°. With a pencil scratch vertical grooves on the dirt packed on one board. Make horizontal grooves on the dirt packed on the other board.



Hold a can with holes in the bottom over one of the soil samples and pour a half liter of water into the can, allowing it to "rain" on the sample. Repeat for the other soil sample.

Compare the soil run-off from the two models by filtering the water in the pan. What conclusions can be drawn regarding erosion? What important implications exist for farmers and landscapers?

Sprinkle straw or grass clippings on both models. Repeat the "rain" activity. Filter the run-off. How does the amount of soil removed compare with that amount eroded with no ground cover?

PURPOSE: To relate weather conditions with the occurrence of rainfall.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

ACTIVITY: Obtain from the high school chemistry teacher the materials to make the following moisture indicator. One-half ounce cobalt chloride, 1/2 ounce sodium chloride and 1 ounce water. Mix the materials together and dip small pieces of white cloth in the solution. When it is dry, a blue color will indicate little moisture, lavender will indicate a changing condition, and pink will indicate much moisture.

Set up a weather station outdoors in a wooden box. In it, place a thermometer, barometer, and the moisture indicator. Record the readings of the instruments (as well as the color of the indicator) daily. Also, record actual weather conditions such as cloudiness and rainfall. How does the barometric pressure seem to be related to rainfall? Is the temperature related to rain or lack of it?

PURPOSE: To create a small (fishless) aquarium in which students may observe types of pond life.

LEVEL: Elementary school

SUBJECT: Science

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: Teacher's Guide, Ecology, Grade 7. Yadkin Valley Economic Development District, Inc., Walnut Cove, North Carolina, 1972. ERIC: ED 081 610

Hours of intriguing investigation can result from a simple pond water aquarium. Children are fascinated by the creatures found in pond water and can easily become familiar with them. As children compare jars of pond water, and later, the water from different ponds, they begin to understand that living things are different in different environments.

Materials for a fishless aquarium can be collected on a class outing. In preparation for the outing, ask each student to bring a one-quart milk carton and a one-quart clear jar or plastic container. Take the milk cartons on the outing.

ACTIVITY: Collect materials this way:

1. Carefully unfold the top of the milk carton so that there is a square opening. Rinse out all traces of milk.

2. Take the milk carton to the pond, lake, or ditch. Scrape a little mud off the bottom and into the milk carton. You can use the milk carton to scrape with. If you scoop the mud up with some other container, be careful not to wash away any aquatic life contained in it. Add mud to the container until the mud is about 2 cm. deep.

3. Fill the rest of the carton with clear water from that source.

4. Add a small handful of any water plant that is available. Many animals live in the plants and will be transferred to the carton with the plants.

5. Refold the top of the carton and bring it back to school.

6. Dump the sample from the carton into the quart jar. Rinse the carton by pouring some water back into the carton. Shake the carton with water. Then pour the rinse water back into the jar. Don't worry about how cloudy the water is; it will settle in a few days. If the jars are set in windows, the plants will stay healthy.

After the mud has settled, the students can start studying the jars. Are there creatures swimming in the water? On the sides of the jars? On the surface of the mud?

Microscopes and magnifiers can be brought out after students have exhausted the investigations which they can make by naked eye. A corner of the room might be set aside with microscopes and a bulletin board established for drawings of observed aquatic life.

Students may observe the creatures in the jars for quite some time before they raise such questions as the following. Be patient!

1. Does my jar have the same creatures as everyone else?
2. Does my jar have as many creatures as someone else?
3. Is the population changing in the jars? Is the number of one creature increasing or another decreasing?
4. Why isn't the water the same color in all the jars?
5. Why isn't the mud the same color in all the jars?

The aquariums should last for several weeks if a few precautions are noted: (1) Don't add food to the water! (2) Keep some distilled water on hand to add as the pond water evaporates. (3) Keep the jars in the coolest part of the room. (4) If there are green plants in some of the jars, keep those jars in the sunlight.

PURPOSE: To become aware of the extent to which living things are composed of water.

LEVEL: Elementary school

SUBJECT: Science
Mathematics

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: Rockcastle, Verne N. Water Wonders. Cornell Science Leaflet, v61 n1, 1967.

ACTIVITY: Involve children in weighing very carefully pieces of plant material such as celery, quarter section of peeled apple, orange, potato, and other fresh fruits or vegetables readily available. Record the weights. Place the materials in a warm, dry place for several days. After they have dried completely, weigh each sample again. What was the percentage of water in each substance?

After a heavy rainstorm it is often easy to find on pavements or sidewalks earthworms or large "night crawlers" that have drowned. Ask a student to bring in several of these freshly killed worms, remove the excess water from them, and weigh carefully on a balance. Place them in a warm, dry place and let them dry out. When they are completely dried out and brittle, weigh them again. From the difference in weights, calculate how much of a fresh earthworm is water.

Do students think that they personally also contain a high percentage of water? What evidence can they offer?

PURPOSE: To observe the effect of polluted water on small fish in an aquarium.

LEVEL: Elementary school

SUBJECT: Science
Social Studies

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Water Pollution. A Unit Developed by the Environmental Education Project Staff, Topeka, Kansas Public and Parochial Schools. ERIC: ED 097 217

ACTIVITY: Secure two glass containers. Two aquaria with air pumps would be ideal but two large-mouth gallon jars will be adequate.

Fill each container about 2/3 full of tap water. Since tap water is typically chemically treated, let the containers stand for 24 hours before introducing a goldfish and/or a couple of small guppies into each container.

Into the "control" container put nothing except small amounts of fish food from day-to-day. Into the second container have children place trash such as cigarette butts, pop cans, candy wrappers, and vegetable cans. Do not clean any of these items before putting them in the water.

Make daily observations of both containers, being especially careful to observe the changes that take place in the "trashy" water. Keep a daily record of observed changes in the water and in the behavior of the fish. If (when) the fish in the polluted container appear to be getting sick, transfer them to the clean water.

Discuss why polluted water is a bad habitat for fish. What evidence have the children seen of water pollution around their community? Who appears to be the worst polluters? What can be done to decrease water pollution? What can you do?

PURPOSE: To learn about agencies which examine water supplies.

LEVEL: Elementary School

SUBJECT: Science
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Stapp, William B. and Dorothy A. Cox. Environmental Education Activities Manual, Middle Elementary Activities. Dexter, Michigan: Thomson-Shore, Inc., 1974.

ACTIVITY: In your community, there should be a division of the water department or county officials whose duty it is to test water. Either you (or some of your students) can determine who is in charge of local water testing. See if this person could speak to your class or attempt to arrange a field trip to his location.

There are many questions which could be asked of this resource person. Among them:

1. How often is the water tested?
2. When did the testing program begin in this city (county)?
3. How can someone living outside of a municipality get their water tested?
4. What is the water tested for?
5. Have there ever been any local outbreaks of disease due to impure or contaminated water?

   If so, ask for dates. Research the event in the local library and/or newspaper office archives.
6. What steps are taken if a water source is found to be contaminated?

PURPOSE: To appreciate the amount of water used daily by the families represented in the class.

LEVEL: Elementary school

SUBJECT: Mathematics

CONCEPT: Water is essential to all human, animal, and plant life.

ACTIVITY: Review with the class the documentable fact that the average American family uses an average of about 60 gallons of water per person per day for cooking, drinking, bathing, washing clothes, washing dishes, washing the automobile, watering the lawn, and so forth.

Involve the class in pouring a gallon of water from one plastic jug to another 60 times to appreciate more fully how much 60 gallons is. Calculate the total number of gallons used daily by the number of children in the class.

Measure the blacktop or parking area around the school building in square feet. Use a rain gauge to measure daily rainfall on the schoolyard for a period of a month or so. After every rain calculate the amount of water that has run off of the blacktop surface. Since one gallon equals 231 cu. in., the calculation to determine gallons is: area in sq. ft x 144 x amount of rainfall in inches or fractions thereof ÷ 231. How often is the run-off equal to the daily needs of the class? What actually happens to the run-off water from the schoolyard? Does it ultimately become some city's water supply? Whose?

PURPOSE: To show the amount of water which a leaky faucet may lose.

LEVEL: Elementary school

SUBJECT: Mathematics

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 5. Edmonds School District 15, Lynnwood, Washington. ERIC: ED 099 216

A leaky faucet does not seem like much of a problem until you begin to sense how much water each person uses daily and how quickly the drops from a leaky faucet add up. Here are some facts that give you an idea of the enormity of the problem.

Each person uses approximately 60 gallons of water every day. This includes water for drinking, washing, and cooking. Add to this the water needed to run a washing machine (30 gallons per load), or a dishwasher, or how much water is used in flushing a toilet (5 to 10 gallons). In addition, consider the amount of water used in industry to provide us with many products we use daily (40,000 gallons to make steel for one car).

ACTIVITY: Create a leaky faucet if one does not exist. Place a measuring cup under the leak and leave it there for five minutes. Check to see how much water accumulates.

Project the amount of water which would leak from the faucet in an hour, a day, a month, a year.

PURPOSE: To show students some of the ways in which water is used every day.

LEVEL: Elementary school

SUBJECT: Social studies

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 3. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 218

ACTIVITY: Write the following questions on the board and have students copy them down. Tell them to answer questions 1-3 based on their uses of water in the next three days.

1. Make a list of all the ways you used water today. Also do the same tomorrow and the next day.

2. Look at your lists. Did you use water the same way every day?

3. What are some ways in which you have used water before, but not in these three days.

4. How might your best friend's list be different from yours?

5. Does everyone use the same amount of water each day?

The responses to question 1 may be written on the board to show the variety of uses for water. Before continuing to other exercises concerning the amount of water used for various activities, the following series of questions may be used to "set the stage" for these activities.

- Do you know how much water it takes to run a washing machine one time? (30 gallons)

- Do you know how much water it takes to grow wheat for one loaf of bread? (300 gallons)

- Do you know how much water it takes to make steel for one car? (4[illegible],000 gallons)

- Do you know how much water is used to make one ton of rubber for tires? (660,000 gallons)

PURPOSE: To dramatize the contrast of water usage in the United States when compared with lesser developed countries.

LEVEL: Elementary school

SUBJECT: Social studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

ACTIVITY: Show the class pictures from textbooks or other sources that show women and/or children carrying water (often on their heads) from the village well to their homes. Indicate that it is not unusual to carry the water a half-mile or more in such situations.

Arrange with the school custodian to provide for class use of a clean 50 or 60 gallon drum or barrel. Indicate that 60 gallons of water per day per person is typical usage in an American home. Have the drum placed at least 100 yards from an outside water faucet. Provide appropriate sized containers for the pupils to use to carry water from the faucet to the drum. (One gallon plastic jugs might serve nicely for smaller children, two gallon buckets should be more appropriate for larger children.)

Involve the class or a small sub-set of the class in carrying water from the well (faucet) to their home (drum). How long does it take? How long would it take one or two persons to do it? How many times would the barrel need to be filled to represent all the water used by the families in the class? If they or their parents had to carry into the home all water used there, would they use less? Where would be the easiest places to save water? The hardest places?

PURPOSE: To consider the relative importance of various uses of water at home.

LEVEL: Elementary school

SUBJECT: Social Studies
Science

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: Managing Minnesota's Environment--A Newsletter for Teachers. April 1977.

ACTIVITY: Present to the class the worksheet shown below that lists some of the common uses of water in and around the home. Ask students to indicate in front of each use their judgment regarding the importance of the use according to the directions given. Ask students, also, to write a short sentence for each use suggesting how water could be conserved in that particular area of use. Develop on the chalkboard a matrix that will show areas of agreement and disagreement in total class response. Discuss these and also other class suggestions for conserving water.

* * *

Below you will find a list of ways we use water in and around our homes. In front of each use write the letters N, I, U, S, C, or R to indicate how important you regard each particular use of water according to the following code:

1. Write an "N" in front of each way that is very important and necessary for living.

2. Write an "I" in front of each way that is important, but not necessary for living.

3. Write a "U" in front of each way that is unnecessary.

4. Write an "S" in front of each way that is important or necessary and in which much could be done to save water. After each of these ways, tell what can be done to save water.

5. Write a "C" in front of each way in which water is used in a manner that part of it is consumed or "used up" by direct evaporation or by transpiration from plants and can't be reclaimed downstream or from groundwater and used again. (Such uses are consumptive uses.)

6. Write an "R" in front of each way in which water is used in a manner that part of it is reclaimed by flowing to streams or the g idwater and used again without evaporation or transpiration. (Such uses are nonconsumptive uses.)

How important I think this use is.	Different uses of water	How to save water
	Drinking	
	Food preparation	
	Regular washing of face and hands	
	Brushing teeth	
	Watering vegetable gardens	
	Making beverages such as coffee and cold drinks	
	Flushing the toilet	
	Bathing in tub or shower	
	Washing dishes	
	Watering lawns	
	Washing clothes	
	Sink garbage disposal	
	Washing cars	
	Washing walks and driveways	
	Wading and swimming pools	
	Water massage	
	Water fights	

PURPOSE: To learn about a city water treatment plant.

LEVEL: Elementary school.

SUBJECT: Social Studies
Science
Art

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 3. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 218

Through the city water department arrange for your class to take a tour of the water treatment plant. Two or three days before your group is to tour the plant, have the students research the general operation of a water treatment plant. Textbooks, encyclopedias, and magazine or newspaper articles may be resources for this task. You may decide to have students work as research teams.

ACTIVITY: Divide the class into three or four groups. Distribute copies of the "Trip to Waterworks" guidesheet. You may instruct the students to complete all stages of the questionnaire, or you may choose to discuss each section as it is completed.

Students are to take their "Trip to Waterworks" guidesheets on the field trip. As the topics which they have listed are covered, places are provided to check each item. Each group should be certain that its items are discussed on the tour.

TRIP TO WATERWORKS

1. Based on what we already know about water treatment, our group would like to find out more about:

____ A. _____

____ B. _____

____ C. _____

2. The questions we will ask to find out these things are:

____ A. _____

____ B. _____

____ C. _____

3. In order to find out more about points in #1, we will look for:

_____ A. _____

_____ B. _____

_____ C. _____

Take this sheet with you on the trip. As questions are answered, check them off on the line provided.

As an additional activity, you may choose to have students draw a picture of the stages which water passes on its trip to their houses or have a large mural on which all the students work.

PURPOSE: To determine the source of each student's home water supply.

LEVEL: Elementary school

SUBJECT: Social Studies
Mathematics

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Stapp, William B. and Dorothy A. Cox. Environmental Education Activities Manual, Middle Elementary Activities. Dexter, Michigan: Thomson-Shore, Inc., 1974.

ACTIVITY: Have students discuss with their parents the source of the family's water supply. If it is a well, ask about the depth.

On the board, record the number of students who obtain their water from a) city water, b) wells, c) cisterns, d) other (specify). Have students make bar graphs to show this information.

Use a line graph to show the depth of wells. Record the depths on the vertical axis and student's name on the horizontal axis.

In urban areas, virtually all of the students may obtain their home water supply from the city. Find out about the source of the city water.

PURPOSE: To provide students with an awareness of the amount of water used in daily activities.

LEVEL: Elementary school

SUBJECT: Social Studies
Mathematics
Art

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: A Multidisciplinary Process Curriculum In Environmental Education, Grade 3. Edmonds School District 15, Lynwood, Washington, 1973. ERIC: ED 099 218.

An awareness of the amount and frequency of water usage in daily living is the goal of this activity. The procedures listed below are intended to provide experiences by which to reach that goal:

ACTIVITY:

1. Have students make a list of all the ways in which their mothers use water in preparing a meal. In addition, have students ask their parents to help them list other ways in which water is used at home. Discuss the variety of uses of water in class.

2. Have students bring empty gallon containers to school. Collect 30 containers. Show the students the collection of containers and tell them that 30 gallons of water is the average amount of water needed to wash one load of clothes. Have the students calculate the amount of water needed to wash four loads; four loads per week for four weeks.

3. Have the students work together in making a radio or television commercial on saving water. Have them write scripts or draw pictures of the events they would want to present.

PURPOSE: To show how frequently water is used in our daily lives.

LEVEL: Elementary school

SUBJECT Social Studies
Art

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 1. Edmonds School District 15, Lynwood, Washington, 1973. ERIC: ED 099 216

Water is essential to life and is helpful to man. From the smallest mountain stream, through swamps, lakes, rivers, and oceans, every type of water area supports fascinating living creatures, each interdependent in the web of life.

There is an increasing awareness of the need to understand and preserve all of these water habitats and the living things associated with them. Water can be found in all degrees of purity in the environment. Water can become polluted naturally. Raindrops pick up solid particles (dust, soot, plant pollen, etc.) and gases from the air are dissolved in them. After a rain, water picks up impurities from minerals in the ground. Many everyday living activities can cause water to become polluted by detergents, human and animal wastes, industries, and fertilizers, among other substances. A fact to remember is that water is limited in our atmosphere and is constantly being recycled. Deterioration of any water environment will affect many types of interdependent living things.

ACTIVITY: Have the students keep a tally sheet of the number of times water is used during one school day. The tally may be continued overnight or over a weekend.

Ask the students to think of a substitute for water for some of these uses. Are there any substances which can replace water for some uses?

Introduce the concept of water pollution. Stress that pollution can occur naturally or may be man-made. Ask students to provide examples of natural and man-made pollution of water.

As an additional activity, you may have students draw pictures of the different ways water is used in the summer and winter.

PURPOSE: To show some of the ways in which water is used in our daily lives.

LEVEL: Elementary school

SUBJECT: Social Studies
Art

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: A Multidisciplinary Process Curriculum In Environmental Education, Grade 4. Edmonds School District 15, Lynnwood, Washington. ERIC: ED 099 219

ACTIVITY: Ask the students to think of specific uses of water. List their responses on the board. Encourage the students to provide only specific uses such as drinking, washing clothes, etc.

After many uses have been listed have the students attempt to group the uses of water into categories and to assign labels to their larger groups. For example, recreation might include swimming, boating, fishing, and ice skating.

On the board, list the larger categories and then attempt to merge any which appear to overlap. Have the students decide what the main categories of water use are. Can some category(s) be said to be more important than others? If water were to become extremely scarce, what would be uses that would be regarded as most essential for life?

Students may be asked to draw pictures depicting the use of water in each of the main categories. Alternatively, students may bring in pictures from magazines which show water use and use the pictures to construct a collage.

PURPOSE: To dramatize how water is reused.

LEVEL: Elementary school

SUBJECT: Language Arts

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Managing Minnesota's Environment - A Newsletter for Teachers, April, 1977.

ACTIVITY: Read to the young children the following story entitled "Wandering Walter, the Water Drop" written by Kathy Bolin, Research Assistant, Department of Soil Science, University of Minnesota. After listening to the story, the children might be asked to write more paragraphs to continue the story. Students could also be asked to write similar stories about Walter's life when he finds himself in the ocean, on a farm, or in the air.

WANDERING WALTER, THE WATER DROP

Walter squirted out of the faucet, bounced off the left side of the tub, and formed a drop on Jimmy's nose. Jimmy is 4 years old and all wet. Walter is a drop of water. Walter watched Jimmy build ice cream cones out of Mr. Bubbles. Just as Jimmy was about to wipe Walter off his nose, Jimmy said to himself, "I wonder where that little drop of water came from?" Walter, not wanting to be brushed off as just any old drop of water, jumped at the chance to talk to someone and said, "Well, of you set me sit here a while, I'll tell you." Jimmy, surprised to hear a drop of water talk, had always wondered what it would be like to be something other than a person. So he folded his arms behind his neck, leaned back against the cool tub, crossed his legs, and listened as Walter began his story.

"I just came from a water treatment plant. I can't begin to tell you how many times I've been through those places. They give us water drops a cleaning. We run around in rivers, through fields, in and out of tubs, sinks, toilets, showers, all kinds of machines; we get a little dirty and have to be cleaned up so we can be used again. Not too long ago, I was up in the mountains. I didn't look anything like I do now. I was white and lacy and twinkled when the sun hit my face. But then it got warm, and I slid off the rock I was sitting on and fell into a tiny stream. That little stream ran into a larger stream that met up with the river that runs through this town you live in.

A lot of my friends never got down here. Take Margie; she got licked up by a deer. Timothy just disappeared. The first town I visited was several miles upstream from here. That's where I met Kristin. She was a person 4 years old, too. She'd just made a cold drink and was rinsing the pitcher. Kristin turned on the water and there I was. Before I could say, "Hi," I found myself going right down the drain and through the sewer into the sewage treatment plant.

The next day I was right back in the big river again. By that time, I was wondering where I'd end up next. There wasn't much time to think about it. To my surprise, soon I found myself in a huge factory running through all kinds of pipes and tubes. It was so noisy, I could hardly wait to get out. People were turning dials and knobs, and pushing buttons. But, wouldn't you know, before long I was in another sewage treatment plant and from there right back to the big river. And now I'm here."

Jimmy didn't want to say goodbye to Walter, but his fingers and feet were beginning to look very wrinkled like the raisins his mother puts in oatmeal cookies. Walter knew, too, he had more work to do and would have to leave soon. Jimmy carefully picked Walter off his nose with his index finger, swished him into the tub with all the other water drops, pulled the plug and watched as Walter whirled down the drain.

"I wonder where Walter will find himself next time," Jimmy said, as he rubbed himself dry with a towel.

PURPOSE: To provide a description of waste water treatment processes.

LEVEL: Elementary school

SUBJECT: Language Arts

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

REFERENCE: Water Pollution. Environmental Education Curriculum: Topeka, Kansas Public Schools, 1973. ERIC: ED 097 217

ACTIVITY: The story of "The Dirty Bathwater" is printed below. You may want to make copies for your students or choose to read the story to the class.

THE DIRTY BATHWATER

Hi! I'm your dirty bathwater. Would you like to hear about me? I've just cleaned up the dirtiest boy in town.

I don't mind getting dirty when I help, but I sure don't like to stay dirty. If I stay dirty it makes me smell bad and look funny. If I stay dirty the rivers, lakes and oceans won't be so good for fish or boats or for swimming at sandy beaches. If I stay dirty I might carry germs and make people sick and that is something water doesn't want to do.

I'm glad to tell you my city has a place to clean dirty water. It's called a waste water treatment plant. Would you like to hear about it? OK, I'll tell you.

When I finished cleaning up this dirty boy, I slid down the drain with all the dirt I was carrying. I ran through some pipes in the ground called sewers. As water runs fast, it can carry more dirt, so the sewers are built going downhill to make it easier for me to run.

Sometimes the sewers get too deep and I can't go downhill anymore. When that happened to me, I went through a pump. The pump spun me around and around like a carnival ride until I was dizzy. Then, like an elevator, it pushed me up high so I could run downhill again.

The sewers are like streets for us and I followed them right to the waste water treatment plant.

A waste water treatment plant is like a factory with pumps, pipes, valves, motors, machines and big tanks, all needed to make dirty water clean.

At the plant in my city, I started by going through some bars called a screen. The screen caught sticks, pieces of paper, and rags that are carried by most dirty water.

After the screen I went into a tank that made me slow down a bit. Remember, I said that when dirty water runs fast it can carry more dirt. When I slowed down a bit, I had to drop some of the heavy pieces of dirt, called grit, and let them fall to the bottom of the tank. Can you guess why this tank is called a grit tank?

Next, I went into a big tank that made me go ever so slow. I almost went to sleep going so slow, but it made me drop all kinds of dirt. The dirt that I dropped here is called sludge. Making me go slow to drop the dirt is called sedimentation or settling. Can you guess what this tank is called? That's right, it's called a sedimentation tank. The sedimentation tank has equipment in it to take out the sludge.

When I came out of the sedimentation tank, I was through with what is called primary treatment. I was feeling quite a bit better, but not nearly as clean as I should be.

Some dirt really sticks to a fellow. You know how sometimes you have to scrub hard to get clean. Well, I still needed a good scrubbing. You use a wash cloth to scrub with, but dirty water is scrubbed by a lot of helpful little fellows called bacteria. The bacteria are so small that you can't see them without special help. The bacteria didn't scrub me with a cloth or brush but they did clean off the dirt that I couldn't drop by myself. That dirt was their food. They gobbled it up and got fat while I got clean.

The cleaning by the bacteria is called secondary, or second step, treatment.

There are two ways that bacteria are kept in a waster water treatment plant. One is called activated sludge and the other is called trickling filter.

In activated sludge, the bacteria float around with us in a big tank called an aeration tank. The aeration tank has air bubbling through it to keep us all mixed together and to give oxygen to the bacteria. I liked the aeration tank. Those bubbles kind of tickled.

I finished up by going through another sedimentation tank. This was to make me leave the bacteria in the plant. They tried to get out and go to the river with me. They had to stay behind to clean other dirty water. You wouldn't want them to get into the river because they had all that dirt that had been cleaned off me and all the other kinds of dirty water.

The people who work in the waste water treatment plants are called operators. They have to see that all the equipment is working right and make sure that we go into the right tanks. The operators had to inspect me and test me in the plant laboratory to be sure that I was clean enough to be put back into

the river. The operators also had to take care of all that dirt that I left behind.

I think the operators are very important people. Don't you?

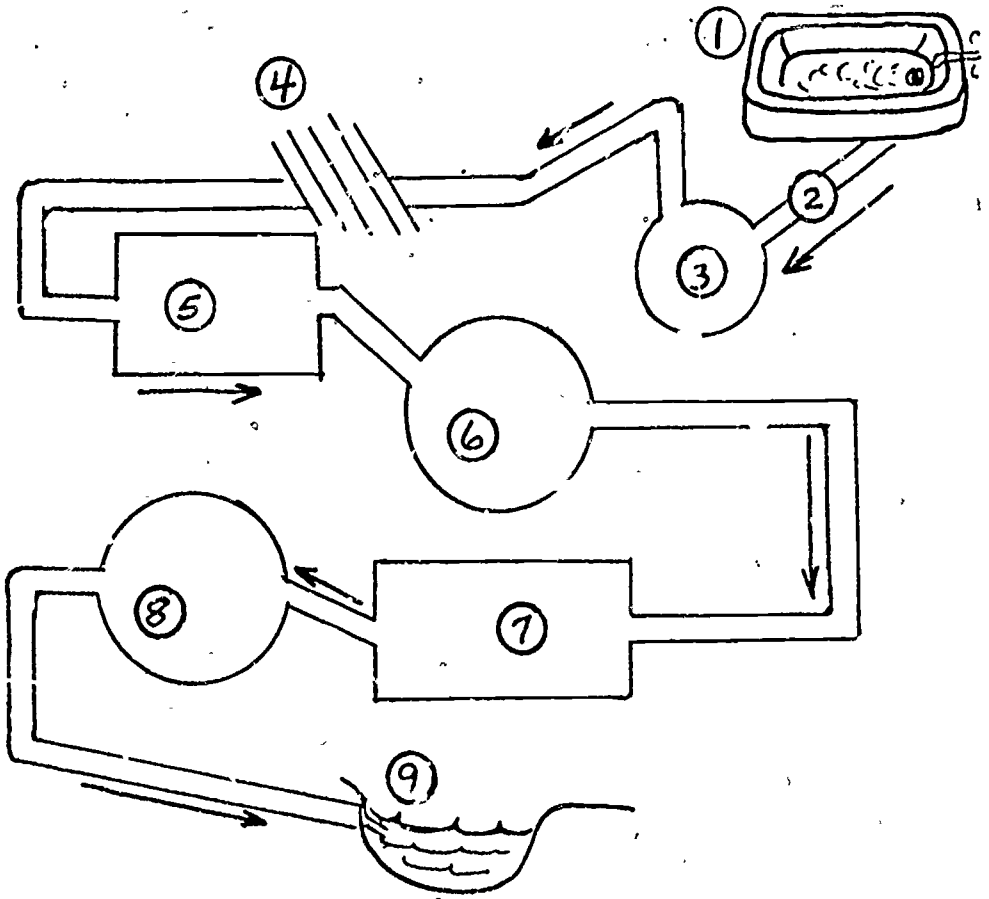
Say, I hope your city has a waste water treatment plant with enough operators to do a good job of cleaning up waste water. Maybe you can visit your waste water treatment plant and watch the operators clean the dirty water.

Remember, water needs to be clean before it goes back to the river.

***

Following the story, copies of the following diagram and word list should be distributed. Students can label each of the numbered sections of the picture with the corresponding word from the list.

WHERE DID THE WATER GO WHEN I DRAINED THE BATHTUB?



DIRTY BATHWATER	RIVER	PRIMARY SETTLING TANK
HELPFUL BACTERIA	GRIT TANK	SECONDARY SETTLING TANK
SEWER	SCREEN	PUMP

PURPOSE: To show the dependence of all life on an uncontaminated water supply

LEVEL: Elementary school

SUBJECT: Language Arts

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Reprinted from Ranger Rick's Nature Magazine, July, 1970, by permission of the publisher, National Wildlife Federation.

ACTIVITY: Have students read the following story. Ask students the the following questions. Why are streams a bad place to dump trash of any kind? What would have been a better method of disposal for the barrel and magazines?

In true life, animals cannot tell about poisoned water. What does this story tell us about responsibility for protecting wild animals?

BIG TROUBLE AT BEAVER DAM
By Sara Bulette
Ranger Rick, July, 1976

Rick, curled up on a low branch of the big oak tree, was watching Ollie Otter finish a new mud slide. It was near the entrance to Terry Turtle's cave, where Rick's Rangers had their headquarters.

Even in the shelter of the tree, Rick could feel the heat of the summer morning sun. Today was going to be a scorcher. He hoped the Rangers would be on time for the meeting. Then they would have all afternoon to rest and play in Shady Pond.

Ollie, poised at the top of his slide, called softly to Rick. "Here comes Cubby Bear. Watch this." Then he yelled, "Cubby! come quick! You've got to see this!"

Cubby went down on all fours and charged toward Ollie, braking at the last minute. Ollie jumped aside and Cubby plunged headfirst, sliding right down on his belly.

"Wish I could make a splash as big as that," sang Ollie as he ran for a tree.

Cubby clawed his way up the bank, growling with rage. From behind the tree, Ollie called, "Thanks a lot. You really put the finishing touches on my slide." Then he made a dive for the water.

"Don't pay any attention to him, Cubby. He can't stand being ignored," said Rick. "Here comes Davey Deer with most of the others. We can start the meeting." He scampered down the tree and up on a stump.

Bluey Jay flew to his lookout post at the top of the big oak and the others gathered around Rick. Ollie sneaked out of the pond and sat close to his slide.

"Looks as though we're all here ept Billy Beaver," said Rick.

"Billy can't make it today," reported Sammy Squirrel. "He told me to tell you the kits are sick and he's trying to find out what they've been eating."

"That's a shame," said Rick. "Nurse Zelda Possum and I had better go over there after the meeting to see if we can help."

Ollie decided not to wait. He eased himself onto his slide and was soon swimming toward Billy's dam on Clear Creek. The meeting was almost over when he got back. He was carrying a dead fish which he tossed on the ground with a flourish.

"Is that a present for me to make up for my ducking?" grinned Cubby.

"Don't dare touch it!" cried Ollie. "It's probably poisoned."

Rick looked at him sternly. "If this another one of your jokes it isn't very funny."

"There's trouble at the beaver dam, Rangers," said Ollie, ignoring Rick. "This wasn't the only dead fish I saw, and Billy's kits are <u>really</u> sick."

All the Rangers began chattering at once. Rick jumped onto his tree stump. "Quiet, everybody! Ollie sure isn't joking this time. There must be something bad in the water. We've got to make a plan--and fast. Think of all the animals that live in that dam!"

"Muskrats, frogs, ducks, watersnakes," wailed Zelda. Then Rick cut her off. "Frances Flicker," he said, "you must fly down and tell Billy Beaver to meet us on the side of the dam near Old Swamp Road. Tell all the others to come to Shady Pond. They'll be safe here because it's upstream."

Then he turned to Nurse Zelda. "Start setting up a hospital in Terry's cave. Terry and Ollie can help you. Odora Skunk and Pudgy Porcupine can take turns standing on guard duty in case Wally Wolf sniffs out the fact that we're in trouble."

"He has," screeched Blue Jay. "I just saw him dodge behind a tree."

"Come with me, Cubby," said Rick. Stiff as a poker, he marched into the woods, then stopped and yelled, "<u>Now hear this</u>, <u>Wally</u>! There's something wrong with the water in beaver dam. It could ruin Clear Creek. You need that creek as much as we do. If you can't help us, at least don't keep us from doing our job."

Out into the woodpath stepped Wally. Slowly, carrying his bushy tail like a flag, he walked away.

"I'm going after him," said Cubby. "The way he pokes his nose into everything, he just may be able to give us a clue as to where to start looking for the trouble."

"Good luck," said Rick. "I guess Wally wouldn't try to tackle you." Then he turned back to the others. "Davey, Sammy Squirrel and Chester Chipmunk, get down to where we said we'd meet Billy. Don't wait for me. I'll follow as fast as I can."

Davey looked nervous. "Maybe we should stick together. Wally might circle back and jump you."

"I don't think so," said Rick, trying to sound as though he believed it.

Davey leaped over a low bush, and Sammy and Chester took to the trees. Soon they were out of sight. Rick scrambled along as fast as he could, keeping a sharp watch in all directions. Then came a crashing in the underbrush and the welcome sound of Cubby's deep voice. "Wait for me!"

As soon as he caught up, he gave Rick the good news. "Wally did see something last night. Two men in a truck pulled off Old Swamp Road where it comes close to the edge of the marsh above Billy's dam. They had a mean dog with them so Wally didn't go too close. He doesn't really know what they did."

"Dumped something, maybe," said Rick. "We're near that spot now."

Rick was the first to see tiremarks on the shoulder of the road. Cubby found footprints leading into a stand of cattails that edged the marsh. Plowing through them, he slipped in the mud. By the time Rick reached him, he was sitting up in shallow water rubbing his head. "I sure hit something hard," he said.

"Get out of there!" cried Rick. "The stuff they dumped could be near you."

As he struggled to his feet Cubby gave a cry of surprise. "Here's what I hit my head on! They look like oil drums."

Just then Bluey Jay landed near them. "I stayed with you till you and Cubby found the marks. Then I flew and told the others at the dam. They're on their way here."

"Good work, Bluey!" said Rick. "There's Davey Deer now. And boy, do I need him."

"Why?" grumbled Cubby. "I could get those drums out of there without any help."

"We're not going to touch them," replied Rick. " I have a feeling Ranger Tom should handle this. Davey can take me to him fast."

A silver moon sailed high above Shady Pond when Davey Deer trotted down the woodpath toward Terry's cave, with Rick clinging sleepily to his back. Pudgy Porcupine, taking his turn on guard duty, had good news for them. The kits were better and no one else was sick. But Shady Pond was crowded with animals from Billy's dam. Some of them thought the whole thing was pretty silly and wanted to go home.

"They can go back tomorrow," Rick announced. " The poison in those drums did not have a chance to get into the dam. The beaver kits and the fish that died

must have poked their noses right into them."

"Did you say poison?" exclaimed Cubby.

"Yes, I said poison. Those drums didn't have oil in them--though that would have been bad enough. They were once filled with a powerful spray to kill insects."

"How do you know?" asked Pudgy.

"Ranger Tom found it out when he took the drums back to his headquarters," replied Rick. "There was enough of the stuff left in them for him to tell, even though the labels had been taken off the drums."

"But the best part," Rick went on, "was that the drums were stuffed with old magazines. Tom could read the address stickers on some of them. That led him to a farmer on Old Swamp Road."

"The man got the drums at a junkyard and planned to use them to float a raft on his farm pond. He had a few drums left over and a bunch of old magazines he wanted to get rid of. So he stuffed them in the drums and sank them in the marsh, 'killing two birds with one stone,' as he said to Ranger Tom."

"Could have been a lot more than two birds," grumbled Cubby.

"He knows that now!" exclaimed Rick.

"Did Tom tell the man about us?" asked a horrified Cubby.

"Of course not!" Rick answered. "Ranger Tom told him he was lucky he hadn't put the raft in the pond yet. If he had, a lot of his fish might have died. And it wouldn't be too good for the people who swim there. Chances are, he'd never have known why."

"Wouldn't he be surprised if he knew he owed his escape to a wolf?" chuckled Cubby.

"For that matter, so do we," smiled Rick.

"Oh, I forgot to tell you," said Cubby. "I thanked Wally when he gave me that tip. He said not to waste time being grateful, just to get on with our job so he could do his."

"That figures," said Rick with a tired grin. "But it's been a hard day. Let's get some sleep. Just be sure someone is on guard duty!"

THE END

PURPOSE: To provide an introduction to the idea of water treatment, pollutant, and polluter.

LEVEL: Elementary school

SUBJECT: Language Arts
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: McDonald's Ecology Action Pack. McDonald Corporation, 1972.
ERIC: ED 106 058

Your city may obtain its water supply from a river or reservoir in which the water is noticeably murky due to sediments. If possible, obtain a sample of the untreated water to show the students the appearance of untreated water.

ACTIVITY: Obtain two aquaria, a pump and filter. Fill one aquarium with water and add sand. Stir up the sand until the water is murky. Pump the water through the filter into the other aquarium. Ask the following questions of your students:

1. Why does the water appear to be more clear now?

2. Where is the sand that was removed?

3. Before water can be used for a city, the same process may have to be done? What is the name of the place where it is done? Does anyone know where it is located?

4. After water is used in a city, it is dumped directly back into a stream? What might happen if it were not cleaned first? Where is our city's sewage treatment plant located?

5. A substance that lowers the quality of water is often called a pollutant. In our experiment with the aquaria, what was the pollutant? In water being used in cities, what are some of the pollutants?

6. The source of a pollutant is called the polluter. Who was the polluter in our experiment? Name some of the possible polluters in a city. Can nature be a polluter? How does much of the sediment get into water?

PURPOSE: To show the occurrence of erosion and the effect of erosion on the quality of life in an environment.

LEVEL: Elementary school

SUBJECT: Social Studies
Art
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 3. Edmonds School District 15, Lynwood, Washington, 1973. ERIC: ED 099 218

ACTIVITY: Take four gallon jugs of water to a hilly site on or near the school grounds. Pour one gallon of water down a place on the hill covered by grass. Compare the path the water takes and the speed at which it travels with that of the same experiment done at another site which has no grass covering. Repeat with another gallon of water at each site.

If a lot of water were to flow down each site, what might be the possible effects on the soil? Are there places in the United States in which water erosion is a serious problem? What National Park is located on a site of past water erosion? (The Grand Canyon)

Ask the students to bring pictures from magazines of water eroded areas. If water erosion occurs, why is this a serious problem for the farmers? What can be done to stop or diminish the problem of water erosion? Make pictures of erosion, its effects, and ways to stop it.

TEACHER'S NOTE: There are several films listed in the teaching resources section which show erosion and its effects.

PURPOSE: To understand one of water's unusual properties.

LEVEL: Elementary-junior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

Due to the unusual arrangement of hydrogen and oxygen atoms in water molecules, water has exceptionally strong ability to stick to itself--this quality is called cohesion. This attraction of water molecules for each other is balanced under the surface of water, but at the water's surface there is no upward pull to counter the downward pull of those below. Consequently, the surface of the water is "pulled down" or exhibits what is called surface tension. This is a property that permits many insects to skoot around on the surface of water.

ACTIVITY: Nearly fill a glass with water. Place a pin or needle on the tines of a fork and gently slip the tines under the surface of the water. If done carefully, the needle will "float", held up by the water's surface tension.

Carefully lower a double-edged razor blade onto the surface of the water. See if it, too, can be upheld by the water's surface tension.

After rubbing the edge of a drinking glass perfectly dry, place it in a shallow pan. Fill the glass until it is brimful. You will note that the water actually extends above the rim. Into the full glass gently slip pins, or thin washers, or thin coins. How many can be dropped into the already full glass before it actually runs over? How can this be explained?

PURPOSE: To study the decomposition of materials in fresh, salt, and soapy water.

LEVEL: Elementary-junior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 6. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 221

ACTIVITY: Obtain 15 small containers of similar size. In five of the containers place fresh water, in another five place salt water, and fill the other five with soapy water. Remove one container with each of the types of water to use as a control. In the four remaining containers of fresh water place glass, metal, paper, and wood, respectively. Repeat the same procedure for salt and soapy water samples.

Observe the containers daily to note any decomposition. At weekly intervals, you may want to check pH and water oxygen level. (See Activity on this procedure.) Plot the pH and oxygen values on a graph.

What materials are affected differently by the various types of waters? Are any of the materials not visibly affected by any type of water?

Would there be a different kind of pollution problem for a paper mill that discharged into a lake and one that dumped into the ocean? What about areas in which industrial and home wastes are mixed together?

PURPOSE: To show the effects of dishwashing detergents on bean seedlings.

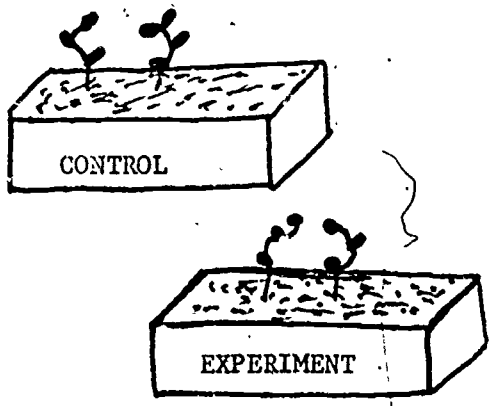
LEVEL: Elementary-junior high school

SUBJECT: Science
Mathematics

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 5. Edmonds School District 15, Lynnwood, Washington. ERIC: ED 099 220.

ACTIVITY: Ask students to bring pint size milk cartons or other small containers. Cut the cartons to a 10 cm. height. Fill with dirt and plant a few garden beans or soybeans in each container. Each student or group will need two containers of bean seedlings. Water plants every 2-3 days. The plants will be ready for the experiment in about 2-1/2 weeks.



Have the students label one container "control", the other "experiment." Have the students or groups prepare different concentrations of detergent-water mixture. Have two groups use one tablespoon detergent per liter of water, another two groups use two tablespoons detergent, and so forth. The water-soap mixture is to be added to the "experiment" beans only; fresh water is added to the control. If you have a large class, you may want to use different kinds of detergent, too.

Add the water-detergent mixtures and fresh water to the experiment and control groups, respectively, every two days. Record the condition of the seedlings at this time.

After two weeks, you may want to: (1) graph the heights of the bean seedlings, or (2) remove the seedlings, dry and weigh them and graph the weights.

Discussion questions:

(1) What effect did the detergent seem to have on the bean seedlings? Did different strengths affect the plants differently? What about different brands?

(2) Did there appear to be a minimum amount of detergent below which no effects are observed?

(3) What materials in detergent affect plants? (phosphates, nitrates)

PURPOSE: To pretest-posttest student knowledge about water pollution.

LEVEL: Elementary-junior high school

SUBJECT: Science
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Water Pollution. A Unit Developed by the Environmental Education Project Staff, Topeka, Kansas Public and Parochial Schools. ERIC: ED 097 217

ACTIVITY: Use test items such as those cited below to obtain measures of students' knowledge before and after a study of water pollution--especially as related to a field trip to a water treatment plant. The correct answers are given at the end of the test.

WATER POLLUTION - PRETEST-POSTTEST

1. Which of these would have the greatest need for clean water?

a. trees and soil
b. houses and cars
c. people and wildlife
d. plants and planes

2. The main reasons that people need clean water are for recreational and personal health.

a. true
b. not true

3. How many gallons of water do most Americans use around home each day?

a. 30 gallons
b. 50 gallons
c. 40 gallons
d. 60 gallons

4. Which of these are considered to be the main polluters of our rivers and streams?

a. boats and ships
b. wildlife and plants
c. factories and cities
d. planes and fishermen

5. Some water pollution is caused by nature.

a. true
b. not true

6. Which of these uses of untreated water would be most likely to make people sick?

a. drinking
b. swimming
c. fishing
d. bathing

7. Which of these activities would probably not be permitted around or in a badly polluted lake?

a. hiking
b. boating
c. picture taking
d. swimming

8. Which of these would probably be harmed the most by dumping untreated sewage into the water?

a. birds
b. boats
c. fish
d. plants

9. Which of these is used by most cities to clean up water before it is used in homes and businesses?

a. treatment plants
b. water towers
c. water pumps
d. pollution plants

10. All cities and towns have waste water treatment plants.

a. true
b. not true

11. The water treatment plant uses lime, carbon, soda ash, alum, fluoride, and which one of the following:

a. iodine
b. calcium
c. chlorine
d. salt

12. What should factories and cities do with water they have used?

a. Run it through a waste water treatment plant.
b. Let it run out on the ground and soak in.
c. Let it run right into the river through a pipe.
d. Use it to make a big lake.

13. Which of these materials is used in the water filter at the water treatment plant?

a. dirt
b. alum
c. sand
d. chlorine

14. At the waste water treatment plant, heavy, solid materials are removed from the water by:

a. secondary treatment
b. primary treatment
c. bacteria treatment
d. sludge pump

15. Which of these does the water treatment plant mix into the water to kill harmful germs?

a. alum
b. lime
c. soda ash
d. chlorine

16. Which of these is a part of the secondary waste water treatment?

a. grease trap
b. bacteria
c. grit tank
d. screen

The correct answer for each question is listed below.

1.	(C)	5.	(A)	9.	(A)	13.	(C)
2.	(A)	6.	(A)	10.	(B)	14.	(B)
3.	(D)	7.	(D)	11.	(C)	15.	(D)
4.	(C)	8.	(C)	12.	(A)	16.	(B)

PURPOSE: To show a method of purifying contaminated water.

LEVEL: Elementary-junior high school

SUBJECT: Science
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Science in the Elementary School, Grades 1-6. State of Tennessee, Department of Education, Division of Instruction, Nashville, 1964.

ACTIVITY: Obtain some water from a pond (late spring or summer water is best). Observe some of the water under a microscope. How many kinds of aquatic life can you observe?

Boil a small amount of the pond water. Observe a sample of this water under the microscope. Does any living aquatic life remain?

To another sample of pond water add 2-3 drops of Purex or Clorox bleach. Observe a sample of this water under the microscope. What effect has the bleach had on the aquatic life?

Water treatment plants want to remove aquatic life from the water for homes. Of the two methods which have been presented, which appears to be the most practical way for the treatment plant to use? The class may want to contact the water department to learn more about water treatment.

PURPOSE: To show a method of cleaning turbid water.

LEVEL: Elementary-junior high school

SUBJECT: Science
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Science in the Elementary School, Grades 1-6. State of Tennessee, Department of Education, Division of Instruction, Nashville, 1964

Rachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc.

ACTIVITY: Obtain some muddy water from a stream or mix sand and soil into water to make a turbid solution. Pour the water into six equal-sized containers. Add different amounts of alum and a small amount of lime to each container. Have students observe what happens in each container.

If desired, the experiment can be performed to determine the optimum amount of alum and lime needed to cause sedimentation.

From this activity, urban students may be interested in the methods which their water treatment plant uses in purifying water. A representative of the plant may be able to provide information as to the amount of alum and lime used per unit of water.

PURPOSE: To provide a model of a watershed.

LEVEL: Elementary-junior high school

SUBJECT: Science
Social Studies
Art

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 4. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 219.

ACTIVITY: On a table, place a small box. With aluminum foil, form a model of a watershed by creating irregular bends and folds in the foil. The box can be placed under the foil to exaggerate stream gradient. Create ponds in the watershed by making small indentations in the foil. Place containers at the mouth(s) of the watershed.

Drops of food coloring may be placed in the ponds to represent sources of pollution.

With a clothes sprinker or other device, simulate rain on the watershed. Have the students note the way in which the water flows across the watershed. In what area does the water flow fastest? Why are flash floods likely in mountainous regions? Why do not sources of pollution affect the entire watershed?

PURPOSE: For students to observe the kinds of aquatic life living in nearby streams.

LEVEL: Elementary-junior high school

SUBJECT: Science
Art

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 4. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 219

The following activity is intended for use in small stream or pond. Aquatic life is much more abundant in early fall than spring.

ACTIVITY: Divide your class into groups of about four students each. Before going to the stream, distribute worksheets to all students along with one pond life book per group.

WORKSHEET
(copy for students)

TASK: Work by yourself or in small groups.
As you approach the stream, observe the stream environment.
Make notes below concerning changes in any of the substances listed.

PLANTS _____

ANIMALS _____

AIR _____

ROCKS _____

WATER _____

TASK: Work by yourself or in small groups.
Using collecting equipment (screens, jelly cups, etc.) collect as many types of aquatic animals as possible.
Put them in the dishpans for observation by the group. (Keep the pan in a cool place.)

TASK: Work by yourself or in small groups.
Using the picture keys which you have been supplied, identify as many of the aquatic insects and animals as you can.

WORKSHEET - Continued

List or sketch the animals you found below.

Description of where found	Type (Name or sketch)	Number found

Return animals to the water as soon as you are finished.

TASK: Work with your group.

A. List four things necessary for you to live:

1. _____
2. _____
3. _____
4. _____

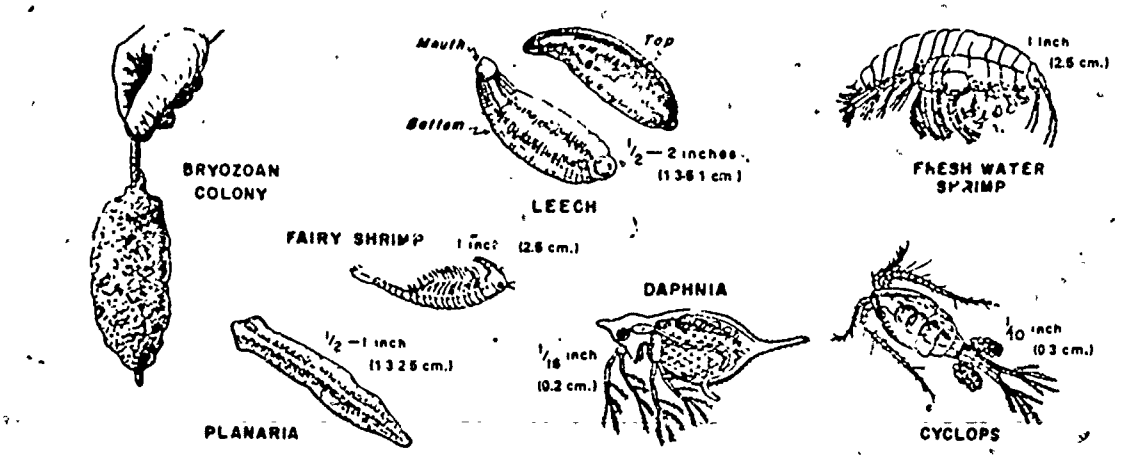
B. List five things you think an aquatic animal needs to live:

1. _____
2. _____
3. _____
4. _____
5. _____

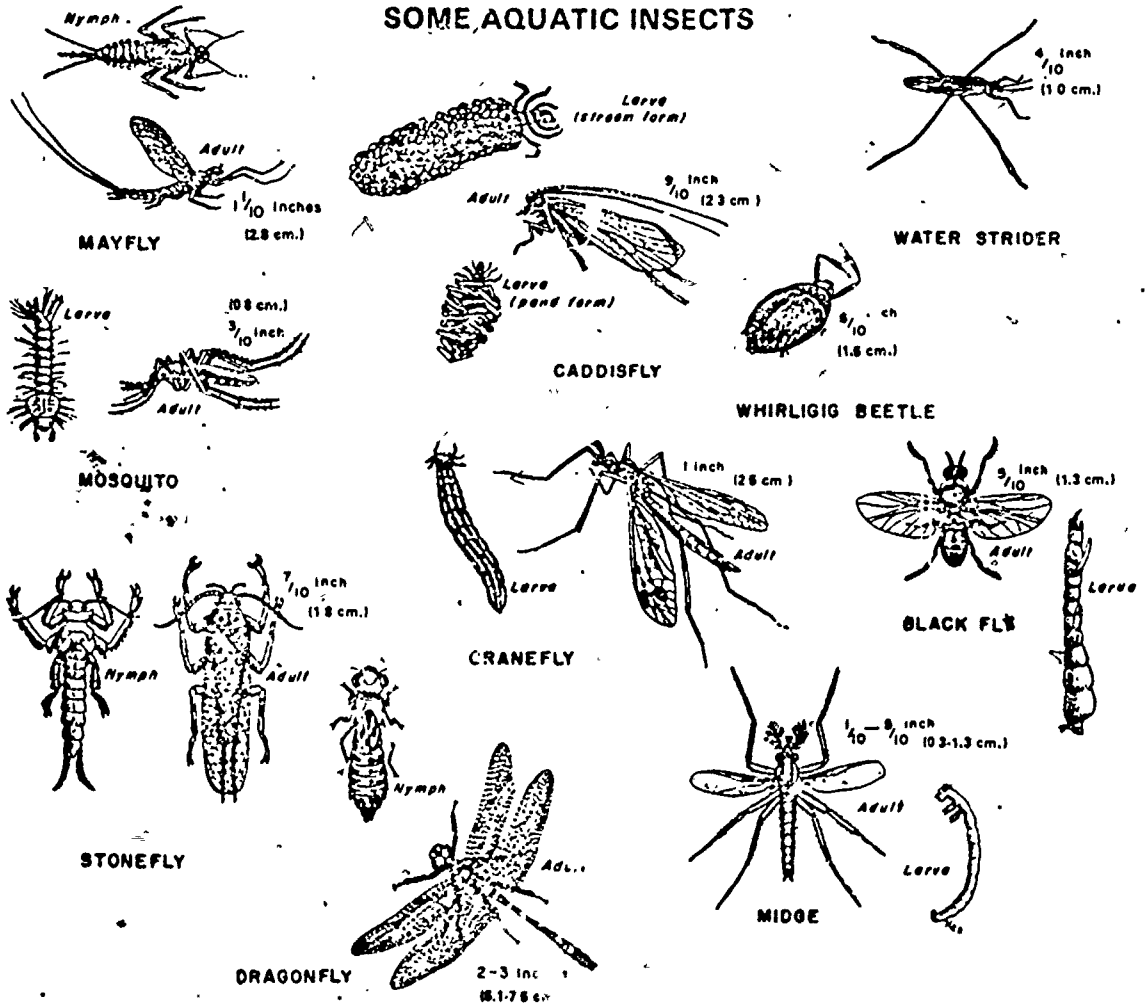
C. Suppose the stream were to become polluted. How would it affect the substances listed in part B?

_____

SOME SUB-SURFACE FRESH WATER ORGANISMS



SOME AQUATIC INSECTS



PURPOSE: To become more aware of the trememdous amounts of water required to produce food and clothing.

LEVEL: Elementary-junior high school

SUBJECT: Mathematics

CONCEPT: Water is essential to all human, animal, and plant life.

REFERENCE: The Christian Science Monitor, March 22, 1977.

An article by Brad Knickerbocker in the reference cited above provides interesting information on terms used by agriculturists to measure water used to produce irrigated crops. This information is analyzed further to show how much water is needed to produce, for example, a pound of tomatoes, or the cotton for a pair of pajamas.

An acre-foot (4,840 sq. yds. 12 inches deep) is reported to be 326,000 gallons, or about what a five-person family uses for all purposes in a year. Since it requires one acre-foot to produce 14,000 pounds of tomatoes on one acre of California truck-farm land, one pound of tomatoes requires about 125 gallons of water.

ACTIVITY: Present to the class the "water equivalents" of the items shown in the Table below. Get estimates from the class on the loaves of bread eaten per day, week, month, year. How many quarts of milk are drunk? Etc. Use the data obtained from the class and the Table for a series of multiplication lessons to point up the enormous amounts of water we consume indirectly. What happens when we have a drought in America's "wheat belt" or a shortage of irrigation water in California?

	Gallons of water
Loaf of bread	136 gals.
Cottom pajamas	900 gals.
Quart of milk	223 gals.
1 lb. of tomatoes	125 gals.
1 lb. of oranges	47 gals.
1 lb. of potatoes	23 gals.

PURPOSE: To examine the recycling of water in an automatic car-wash facility.

LEVEL: Elementary-junior high school

SUBJECT: Science
Mathematics

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and improve water quality. It is to everyone's advantage to develop and practice these skills.

ACTIVITY: Arrange to have an entire class or a small group of students visit a car-wash during a time of day when it is not too busy. Ask the operator or someone who is very knowledgeable about the operation to discuss questions such as the amount of water needed to wash a car as it moves through the car-wash. How much of this is recycled? How is it cleaned in the recycling process? Is clean "unused" city water used in the final rinse phase? Does the operator think it would be appropriate to "close down" automatic car washes during periods of severe drought?

Discuss with the operator, also, the amount of electricity required to operate the conveyor, brushes, and fans in the automatic car-wash. Possibly data concerning the amount of electricity used per month and the number of cars washed can be secured.

Involve the class in duscussing why automatic car-wash facilities have become so popular. It is a good idea to use water and energy in this way?

PURPOSE: To examine an idea for saving water in restaurants.

LEVEL: Elementary-junior high school

SUBJECT: Social Studies

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

In recent months signs have appeared in some restaurants or on their menus indicating that drinking water will be served to patrons only if they request it. The notices report that such practice will save not only the first glass of water, but several times as much water will be saved as a result of fewer glasses being processed through the restaurant's automatic dishwashing machines. Additional savings result from reductions in the use of electricity and detergent in the dishwashing process.

ACTIVITY: Ask individual or small groups of students to interview restaurant managers or others who work in food serving establishments and ask them what they think of this idea. Does the idea sound sensible? Under what conditions, if any, would they be willing to use it? How do they think customers would react to the practice? In what ways does the restaurant try to conserve water?

Examine interview data in a class discussion. Is there any evidence of concern about actual or potential water shortages in the community?

PURPOSE: To study the effects of various water samples on plant growth.

LEVEL: Elementary-junior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

ACTIVITY: Fill nine small planting pots with sand, pearlite, or other non-organic medium. Plant in each pot several beans or other fast-growing seeds.

Divide the pots into groups of three and make provision to water each group regularly with identical amounts of different kinds of water such as (1) tap or well water, (2) distilled water, (3) water from a stream or river. Review with the class the reasons for using nine planting pots rather than three in this experiment.

Observe the sprouting and growth of the plants for a period of several days to ascertain differences, if any, in rate of growth that appears to be related to types of water.

In discussing results the children will need to know that distilled water contains no minerals or ions such as carbonates, nitrates, sulfates, or phosphates found in river and tap water. Tap water, typically, also contains more chlorine ions than does stream water.

Is drinking water the best type for growing plants? How does water get "filled up" with everything found in it?

PURPOSE: To investigate the optimum amount of water needed to promote plant growth.

LEVEL: Elementary-junior high school

SUBJECT: Science

CONCEPT: Water is essential to all human, animal, and plant life.

Agriculture is estimated to use more than 75 percent of the water consumed in the United States. Tremendous amounts of water are needed to produce the vegetables, fruits, and other crops grown on irrigated lands in the semi-arid praries and in the arid southwestern portion of the country. There is evidence to suggest that some farmers irrigate too often, too much, or at the wrong time. Obviously, all of these mistakes waste water, one of the most valuable resources in these areas.

ACTIVITY: Engage the class in designing and conducting an experiment to determine the optimum amount of water and watering schedule for plants to be grown in the classroom. Plans should include identical soil in identical flower pots, equal light and heat, no difference in quality of seeds (peas or beans) used, identical depth of planting seeds and so forth. Water each pot identically until plants appear; then vary the amount of water and the watering schedule in some definite pattern such as the following:

Group 1 (water every other day)
- Pot 1 - no water
- Pot 2 - X amount (judged to be inadequate)
- Pot 3 - 2X amount
- Pot 4 - 4X "
- Pot 5 - 8X "
- Pot 6 - 16X "

Group 2 (water every fourth day) Same amounts as above

Observe the growth and appearance of the peas. What appears to be the optimum amount of water and the better watering schedule?

PURPOSE: To examine a localized water cycle.

LEVEL: Elementary-junior high school

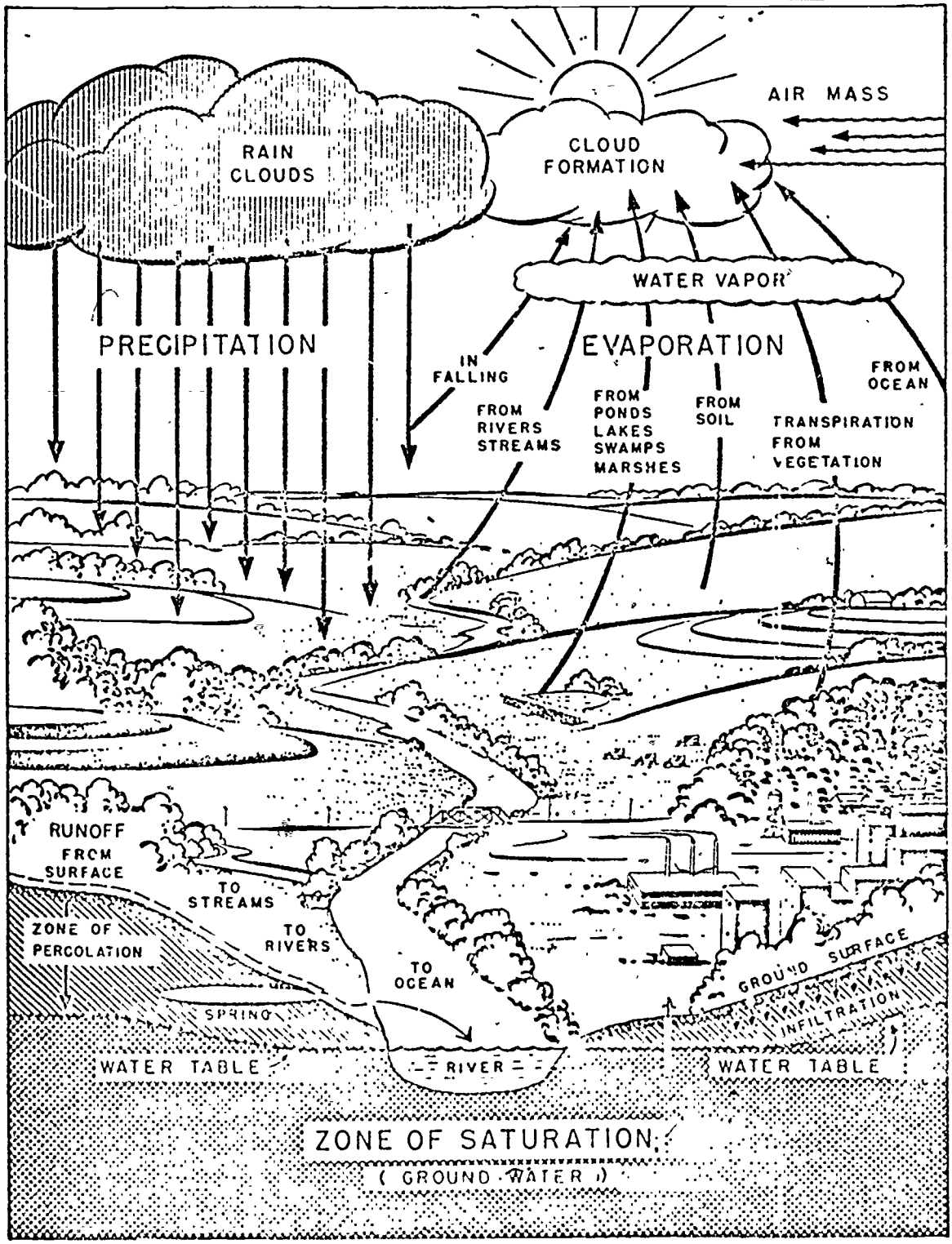
SUBJECT: Science
Art

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Water and You. 4-H Circular 618, Cooperative Extension Service, The Ohio State University, Columbus, Ohio 43210.

ACTIVITY: Prepare and use a transparency showing many elements of the hydrologic water cycle such as are depicted in the picture below. Review carefully with the class the details shown, such as (1) various sources of water vapor, (2) the route(s) taken by surface runoff, (3) zone of percolation, and (4) water table. Identify specific lakes, swamps, ocean or gulfs that provide most of the water vapor that ultimately falls as rain in your geographic area. Identify also the streams and rivers that carry away surface runoff. Provide information regarding the depth of the water table in your area.

Ask each student, as a homework or class assignment, to make a full page free-hand drawing of the picture, inserting all major details shown.


AIR MASS
RAIN CLOUDS
CLOUD FORMATION
WATER VAPOR
PRECIPITATION
EVAPORATION
IN FALLING
FROM RIVERS STREAMS
FROM PONDS LAKES SWAMPS MARSHES
FROM SOIL
TRANSPIRATION FROM VEGETATION
FROM OCEAN
RUNOFF FROM SURFACE
TO STREAMS
TO RIVERS
TO OCEAN
ZONE OF PERCOLATION
SPRING
GROUND SURFACE
INFILTRATION
WATER TABLE
RIVER
WATER TABLE
ZONE OF SATURATION
(GROUND WATER)

PURPOSE: To make a waterscope for underwater observation of aquatic plants and animals.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

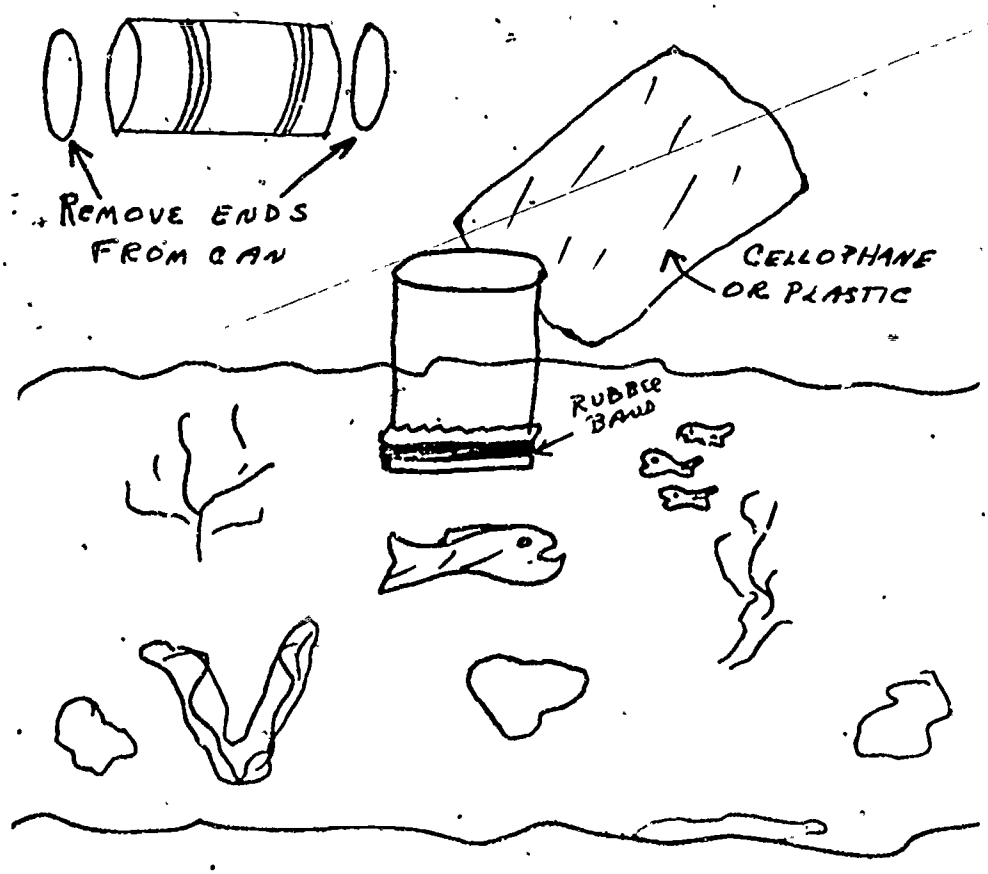
CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION:

1. Remove the top and bottom from a No. 10 can. Pound the edges of the can with a hammer to make them smooth.
2. Paint the inside of the can with flat black paint and allow it to dry. This reduces reflection.
3. Attach a piece of cellophane or plastic over one end of the can with a rubber band.
4. To use the waterscope, place the covered end of the can beneath the surface of the water.

ACTIVITY: Search along a pond bank or lake shore for underwater plants and animals. Make drawings of what you see.



PURPOSE: To make a Secchi Disk to determine the clarity of water.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

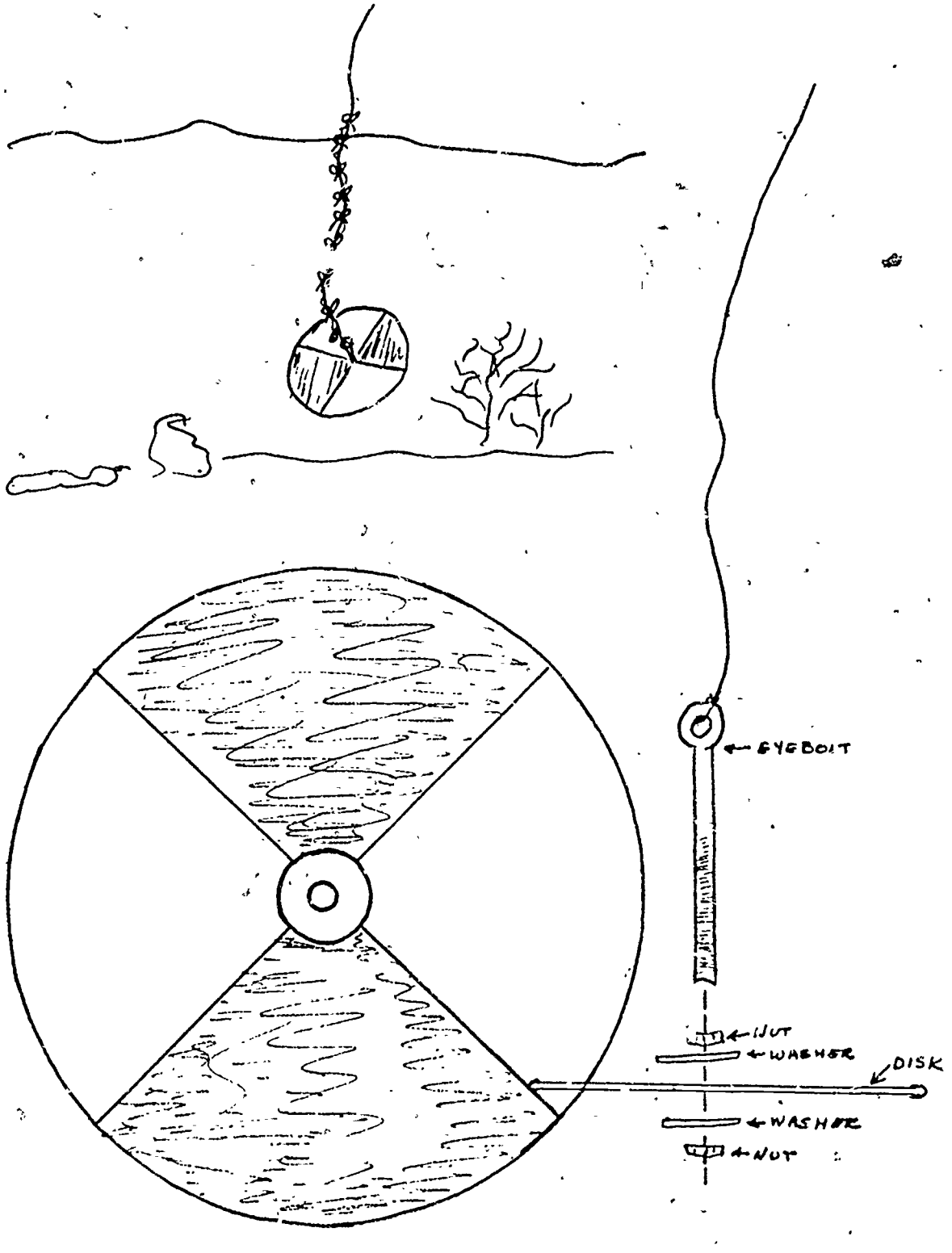
REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION:

1. In a large tin can lid or disk cut from metal drill a hole in the center for an eyebolt.
2. Place metal washers and nuts on either side of the disk.
3. Paint the disk black and white as shown by the diagram.
4. Attach a heavy string to the eyebolt and mark the string with ribbons at 1/4 meter intervals. You may wish to attach weights to the disk so that it will sink smoothly into the water.

ACTIVITY: Lower the disk into water until it disappears. Take a reading of the depth. Allow the disk to sink an additional distance, then raise the disk until it becomes visible. Take this depth reading and average with the first to obtain the limit of visibility.

Determine limits of visibility in different bodies of water. Why are these values different? How is the limit of visibility related to the turbidity of the water?


EYEBOLT
NUT
WASHER
DISK
WASHER
NUT

PURPOSE: To make instruments to determine the depth and water temperature in a stream.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION: A. To construct a depth gauge:

1. Attach weight securely to rope.
2. Mark rope at intervals with ribbons.

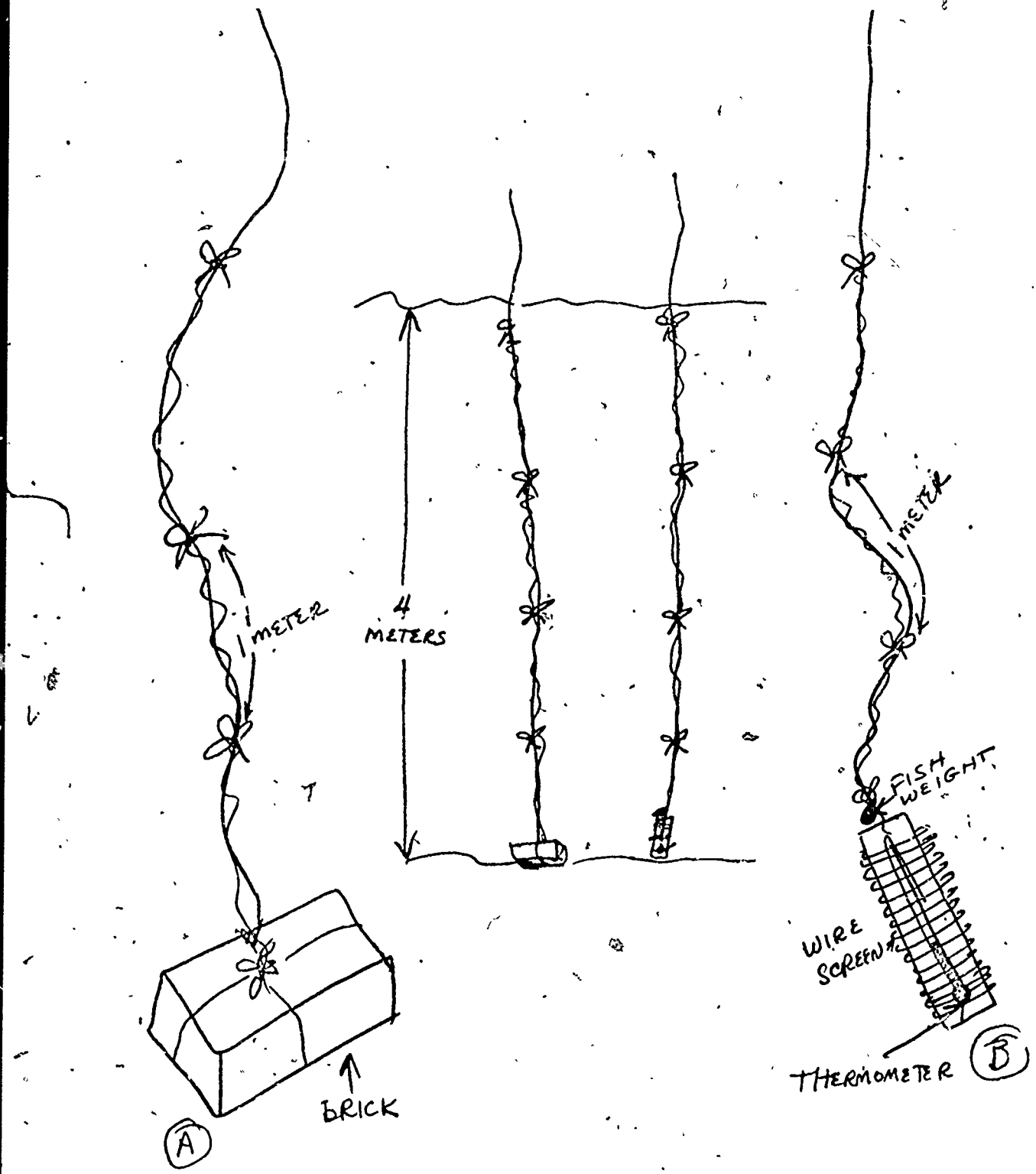
To use the depth gauge, lower the weight and record depth. Map the depth of a stream by moving the depth gauge from one side to the other.

B. To construct a temperature gauge:

1. Tie string to a thermometer.
2. Wrap wire screen around the thermometer to keep it from breaking.
3. Mark the string at regular (2 meters or so) intervals with ribbons.
4. Attach a small weight to the thermometer.

Lower the thermometer to a certain depth and let it remain there for a few minutes to obtain a fairly accurate reading. Determine water temperatures at different depths and locations.

ACTIVITY: Does the water temperature of a stream along a shaded bank vary from that in open water? How is water temperature related to water depth? Plot lines of equal temperature (thermobars) in a stream.


1 METER
4 METERS
BRICK
A
1 METER
FISH WEIGHT
WIRE SCREEN
THERMOMETER
B

PURPOSE: To make a device by which to measure the turbidity of water.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

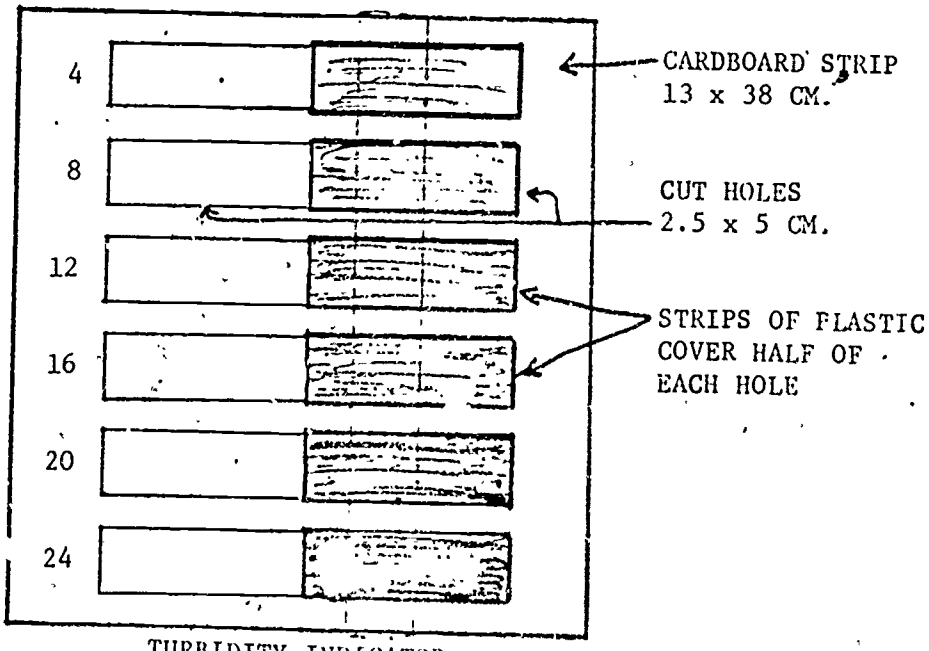
REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION:

1. Cut a piece of cardboard 13 cm. by 38 cm.
2. Using a razor blade or hobby knife, cut six holes 2.5 cm. x 5 cm. equally spaced along the cardboard strip.
3. Layer plastic strips over half of each opening, increasing the number of layers over each section. Tape into place.
4. Indicate the number of layers of plastic next to each hole. You may want to make an indicator with a broader range scale.
5. To use the turbidity indicator, place a water sample in a test tube and hold next to your indicator. Record the number which best matches the color of the water sample.

ACTIVITY: Collect several water samples from various sources such as the faucet, stream, lakes and reservoirs. Determine the turbidity of each sample.

What are some possible causes of turbid water? Is water high in turbidity necessarily polluted? How can the turbidity of water affect animal populations?



TURBIDITY INDICATOR

PURPOSE: To make an aquatic plant collector for use in water study activities.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

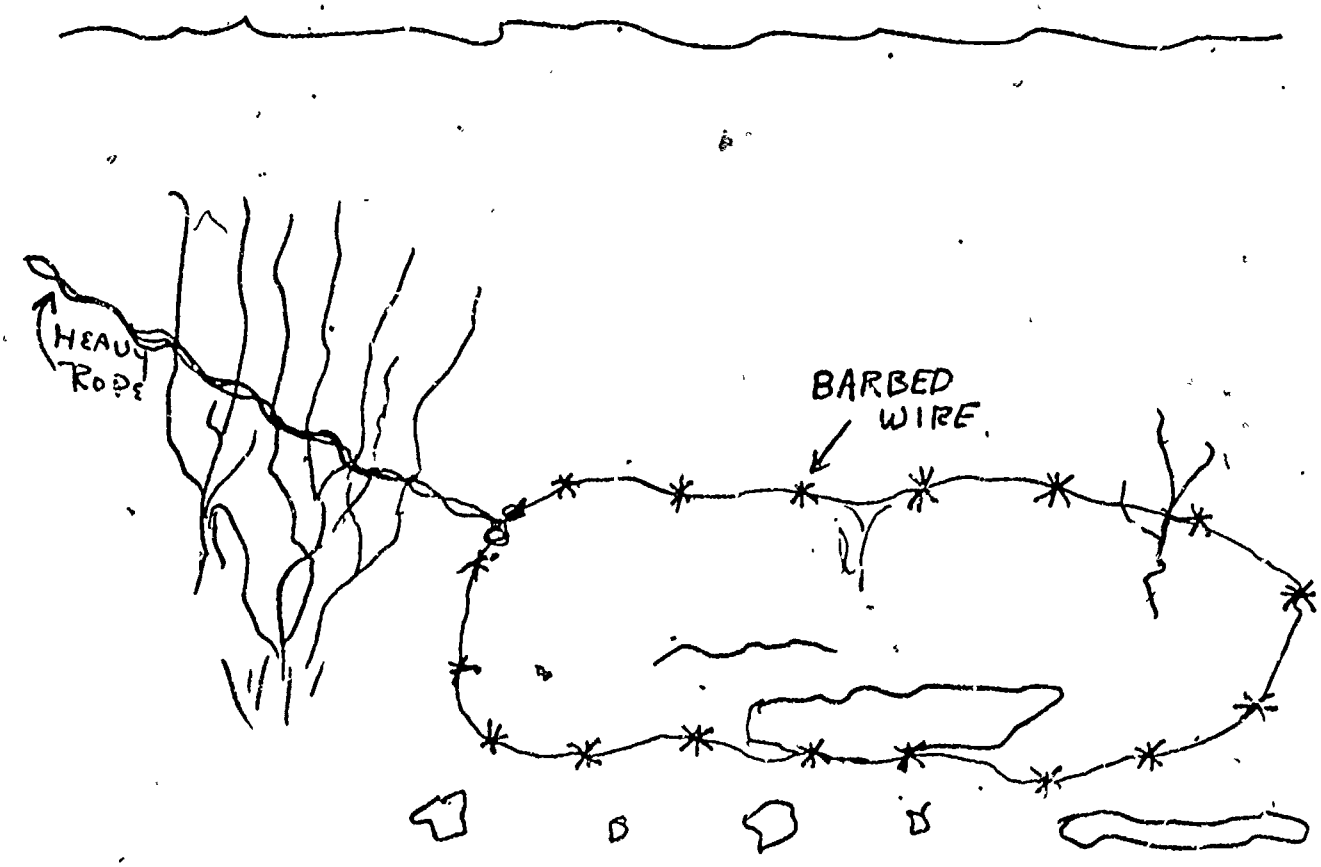
CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1964.

CONSTRUCTION:

1. Cut a piece of barbed wire 1 to 1-1/2 meters long.
2. Connect the ends of barbed wire together and attach to the end of a heavy rope.
3. To use, lower the barbed wire to the bottom of a lake or pond and pull slowly through the water. Raise the rope and remove plant life.

ACTIVITIES: Compare the plant life from several bodies of water. Why does the plant life flourish in some water and not in others? How is plant growth related to water depth? Temperature? Of what value is plant growth to the aquatic community?



PURPOSE: To make a stocking plankton net and a screen sieve to use in water study activities.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION:

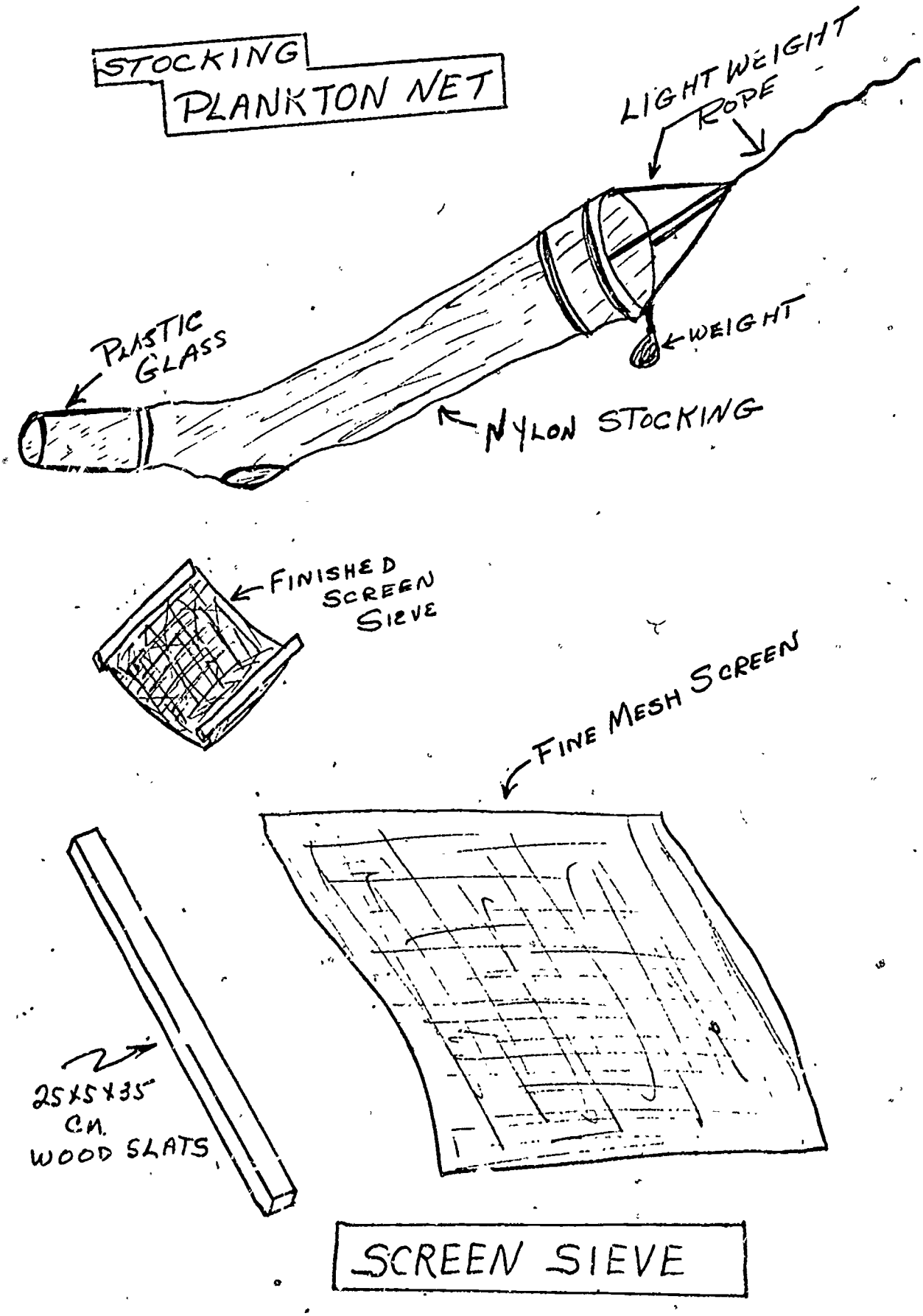
STOCKING PLANKTON NET

1. With wire form a ring to fit inside the open end of a nylon stocking. Attach with needle and thread.
2. Cut the toe of the stocking and fit it over a plastic glass. Attach stocking to plastic glass with wire or tape.
3. At the opening of the stocking connect four pieces of string and tie them together to form a towing line (as shown in the diagram).
4. To use, hold the net in a stream or tow through a lake. It may be necessary to tie a small weight to the opening where the tow lines connect.

SCREEN SIEVE

1. Cut four 2.5 x 5 cm. pieces of wood 35 cm. long.
2. Nail the slats on either sides of a 35 cm. square piece of fine mesh screening.
3. Use the sieve to scoop debris and sediment from lakes or streams for examination.

ACTIVITY: Use the plankton net and screen sieve in water study activities. The materials collected from streams, lakes and ponds can be compared.


STOCKING
PLANKTON NET
LIGHT WEIGHT
ROPE
PLASTIC
GLASS
WEIGHT
NYLON STOCKING
FINISHED
SCREEN
SIEVE
FINE MESH SCREEN
25 X 5 X 35
CM.
WOOD SLATS
SCREEN SIEVE

PURPOSE: To make a sediment scoop for use in water study activities.

LEVEL: Elementary-junior-senior high school

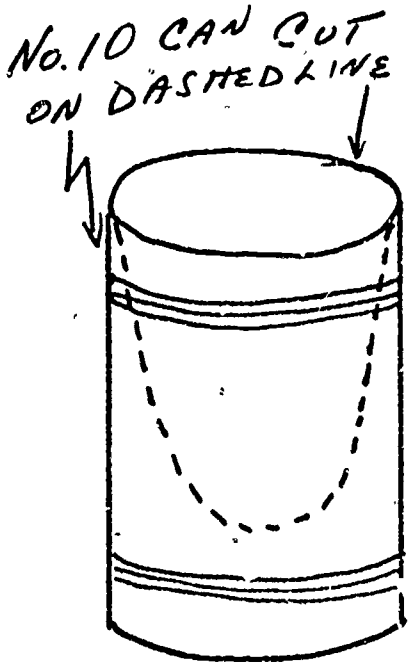
SUBJECT: Science

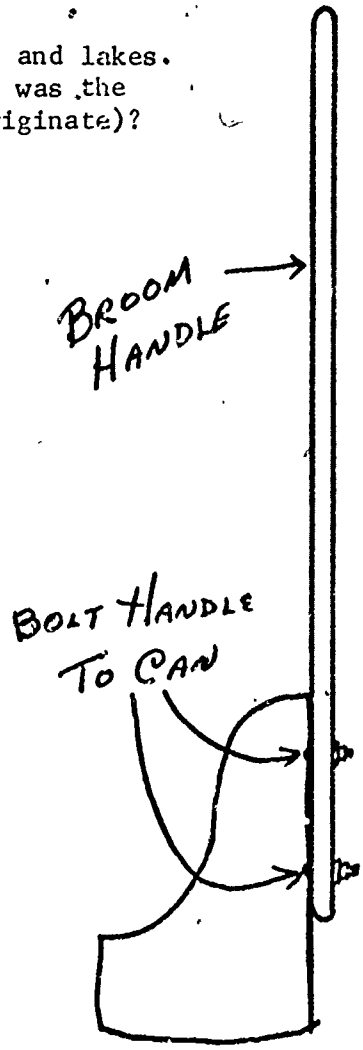
CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: Interstate Printers and Publishers, Inc., 1964.

CONSTRUCTION:
1. Using tin snips, cut a No. 10 can as shown in the diagram.
2. Punch holes in the bottom of the can.
3. Drill two holes through the can and broom handle and attach with nuts and bolts.
4. To use, scoop sediments from pond or lake bottom.

ACTIVITY: Study the organic debris found in ponds and lakes. Are there living organisms in it? What was the debris at one time (from what did it originate)?





PURPOSE: To make a rake dredge for use in water study activities.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

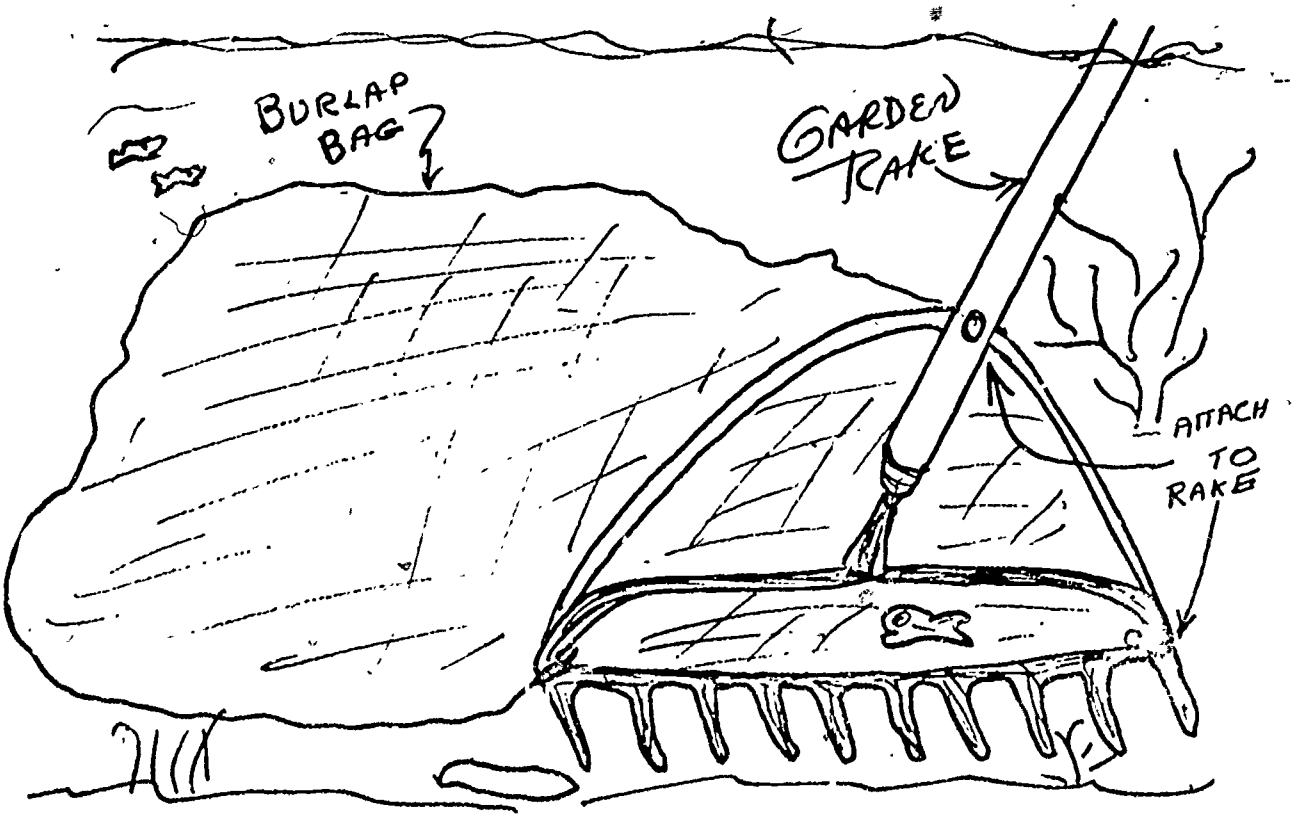
CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1974.

CONSTRUCTION:

1. Lace wire through the perimeter of the opening of a burlap bag and around the crosspiece of a garden rake as shown in the diagram.
2. Pull the bag up until the mouth of the bag is fully open and forms a triangle with the rake.
3. Drill a small hole in the rake handle and attach the bag at this point.
4. To use the dredge, rake along the bottom of a stream or pond.

ACTIVITY: Obtain samples from pond and stream bottoms. Do differences exist? Dredge rocky, sandy and weedy locations. Note any differences in plant and animal life obtained.



PURPOSE: To make a water sampler to use in water study activities.

LEVEL: Elementary-junior-senior high school

SUBJECT: Science

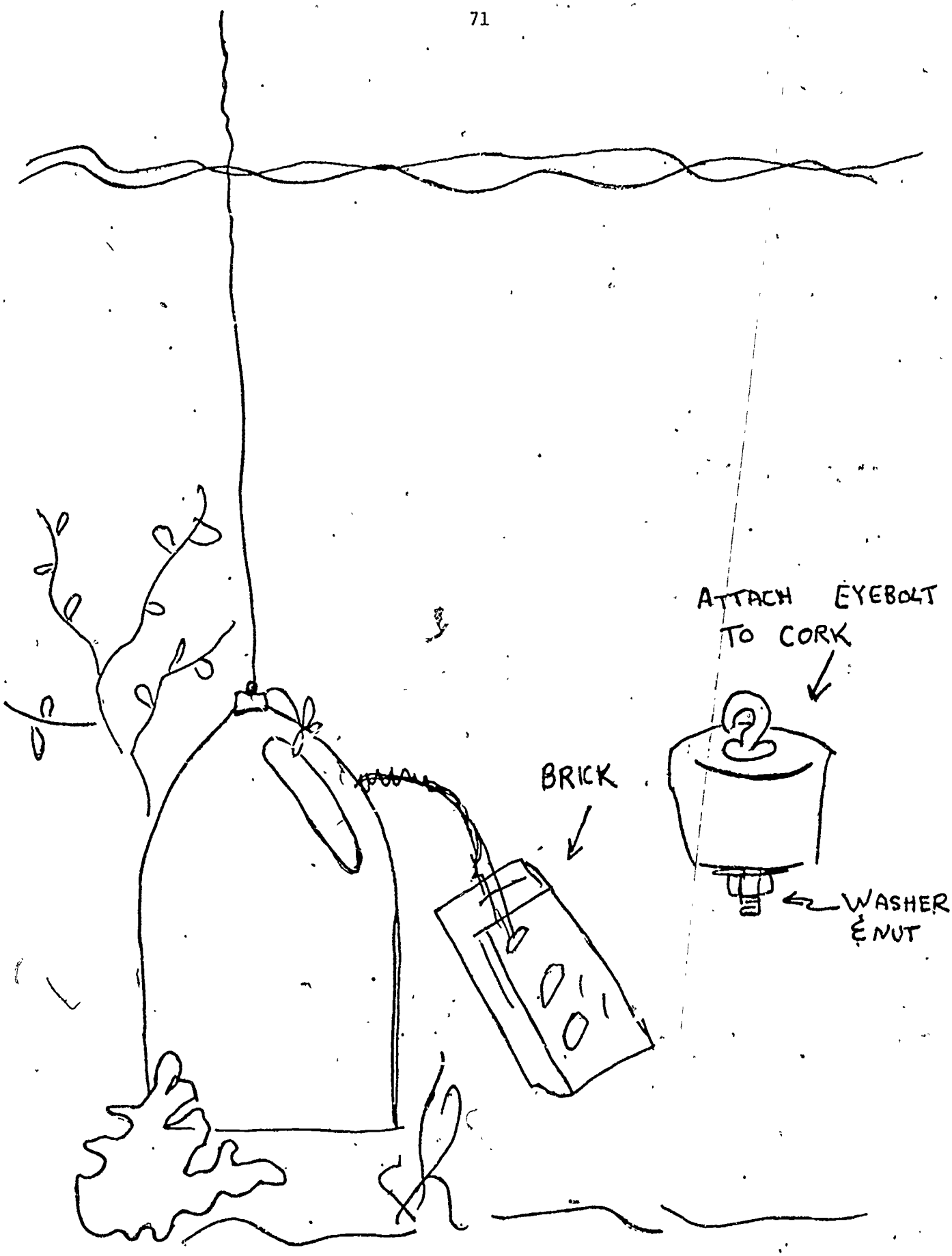
CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Bachert, Russel E., Jr., and Emerson L. Snooks. Outdoor Education Equipment. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1964.

CONSTRUCTION:

1. Find a rubber stopper to fit a 1/2 gallon plastic bleach container.
2. Drill a hole through the center of the stopper, put in an eyebolt with nut and tighten the eyebolt with nut and washer.
3. With a heavy rope, tie a brick to the handle of the container.
4. With twine, tie the stopper to the handle of the container (provide slack as shown in diagram) and allow enough twine for the bottle to be lowered to the depth of the bodies of water to be sampled.
5. Place the stopper firmly in the bottle.
6. To use, lower the twine to the desired depth and with jerking action remove the stopper from the bottle. Allow the container to fill with water before bringing to the surface.

ACTIVITY. With water samples from various depths, water temperature and dissolved oxygen amounts can be calculated. In addition, water at different depths can be studied for the organisms present.


ATTACH EYEBOLT TO CORK
BRICK
WASHER & NUT

PURPOSE: To show the effect that bodies of water have had on the culture, in particular the music, of an area.

LEVEL: Elementary-junior-senior high school

SUBJECT: Music
Language Arts

CONCEPT: Water has recreational, aesthetic, cultural, and inspirational values which contribute to the quality of human life.

REFERENCE: Water Pollution. Environmental Education Curriculum. Topeka, Kansas Public Schools, 1973. ERIC: ED 097 217

ACTIVITY: Listen and/or sing the following songs. Have students research the history of the song, its composer, and the body of water. How does the song tell of the importance of the water to the people of the area?

Songs about water:

"Shenandoah"

"Roll on Columbia"

"On the Banks of the Wabash"

"Old Man River"

"Up the Lazy River"

"Down by the Ohio"

"It Never Rains in Southern California"

"Erie Canal"

"Swanee"

"Down by the Old Mill Stream"

PURPOSE: To consider substances found in "pure" drinking water.

LEVEL: Junior high school

SUBJECT: Science

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Dublin, Louis I. Water Fluoridation: Facts, Not Myths. Public Affairs Pamphlet No. 251B, Public Affairs Pamphlets, 381 Park Avenue, South, New York 10016.

ACTIVITY: Review with the class the idea that pure (safe) drinking water is not the same as pure distilled water used by pharmacists or chemists to make solutions. If conditions permit, demonstrate an apparatus that can make distilled water in the laboratory. Provide opportunity for students to taste distilled water.

Indicate that the mineral residue found in the bottom of a tea kettle or in the raw water flask used in a laboratory distillation setup is very likely to contain, among other minerals, a small amount of fluoride compounds. Review with the class how these mineral compounds have been dissolved in water as it moves through rock layers or over the surface of the land.

Indicate that dentists have learned that children living in cities such as Aurora, Illinois and Stratford, Ontario, where the natural drinking water contains about one part of fluoride compound per million parts of water have about 60 percent fewer cavities than do children who grow up drinking fluoride-free water. Many cities now add small amounts of fluoride to their drinking water. Is this a good idea? Does you city do it? Many cities also add small amounts of chlorine gas to their drinking water. Why? When people use the term "pure drinking water", what do they really mean?

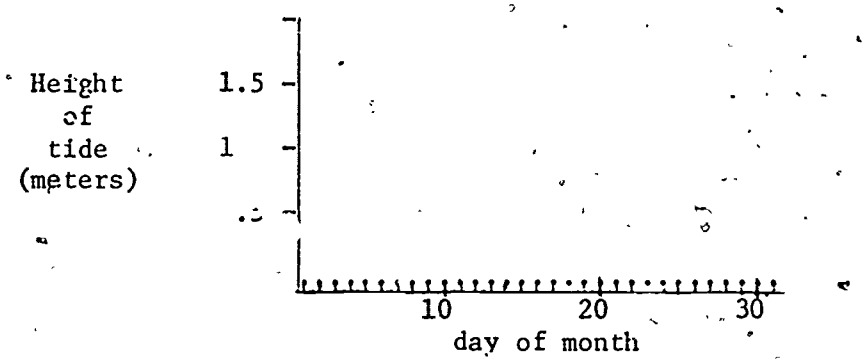
PURPOSE: To show the relationship between tides and moon phases.

LEVEL: Junior high school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

ACTIVITY: From a newspaper or tide tables (available in some sporting goods stores) obtain information concerning the heights of the tides at a particular location for one month. On a graph like the one below, plot height of the tide versus day of the month.



In addition, record which days the different phases of the moon occur:

		day of month
○	new moon (no moon)	_____
◐	first quarter	_____
●	full moon	_____
◑	last quarter	_____

On the graph above the day of month axis, place the symbols for the four phases of the moon.

Ask students to state the relationship which occurs between the moon phases and height of tides. When do the highest tides occur?

What would a graph look like if it were drawn for another month? (It would repeat itself.) Why might the launching of a ship be scheduled for the new moon or full moon times of a month?

D-day, June 6, 1944, coincided with a particular phase of the moon. You may have students who will research the event and find the importance of the moon on the invasion of Normandy.

If your school has a model solar system, the relationship of the earth, moon, and sun, and its effects on tides can be easily shown.

PURPOSE: To examine the importance of watersheds in water management.

LEVEL: Junior high school

SUBJECT: Science
Social Studies

CONCEPT: The ultimate goal of water management should be to promote the highest and best quality of life for everyone.

REFERENCE: Quigg, Philip W. Water--The Essential Resource. National Audubon Society, 950 Third Avenue, New York, New York 10022, 1976.

Review with the class the importance of vegetation, particularly forest lands, in reducing run-off of water during periods of heavy rainfall. Only suitable vegetation and proper land-use practices upstream can protect rich agricultural land and the persons who work it in the lower river valleys from the extremes of too much and too little water. Action must be taken to restrain deforestation, burning, overgrazing, and improper hill farming in the watershed area if floods are to be minimized.

ACTIVITY: Invite to the class a resource person from the Soil Conservation Service or the National Forest Service who will be able to show the watershed area in which the school is located. Ask him or her to locate and/or discuss areas that are primarily forested, contour cultivated, clean crop cultivated, and so forth. Solicit the resource person's ideas concerning what can or should be done to "manage" the watershed. Is it possible to accomplish this management without much government involvement? Why or why not?

After discussion along the lines suggested above, ask the children to review the problem with their parents for subsequent follow-up discussion the next day. Should city dwellers, for example, who are affected by downstream flooding, have anything to say about forestry or farming practices upstream that increase the frequency and size of floods? If the answer is yes, what responsibility must the city assume? How can this be done? Or should we take the position that all floods are "acts of God" and there is nothing man can or should do to prevent them?

PURPOSE: To study the effect of oil pollution on fresh water and salt water.

LEVEL: Junior high school

SUBJECT: Science
Social Studies

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 6. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 221

ACTIVITY: Divide the members of the class into a number of small groups. Each group will need samples of different kinds of oil (olive oil, cooking oil, 3 in 1 oil, motor oil, etc.) and twice as many containers as kinds of oil in which to place fresh and salt water. Fill half the containers with fresh water, the remainder with salt water. With eyedroppers, have the groups add 5 drops of each kind of oil to containers of fresh and salt water. Make similar observations after 15, 30, and 50 drops. Why do the oils behave differently?

If bird feathers are available, have students dip them into the oil-water mixture and note what happens. Why are oil spills threatening to bird populations?

With sponges, paper towels, spoons, or objects of their making, have students attempt to clean up oil from the water samples. Have each group report on the success of their methods. Are the same methods of oil removal equally effective in fresh and salt waters? In addition to the type of water, what are some other factors which may differ in fresh water and salt water situations?

PURPOSE: To involve students in determining the amount of water used in their homes.

LEVEL: Junior high school

SUBJECT: Mathematics

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: Environmental Education Curriculum Infusion Units. General Education and Curricular Services, The University of the State of New York/The State Education Department, Albany, New York 12234.

ACTIVITY: Ask students whose home water supply is metered to bring to class their water bills for the preceding several years. The teacher should provide "typical" home water use data (his own?) for students who aren't able to bring theirs.

Have students compute the average daily, per person, use of water for selected households. Instruct the class to calculate the mean, median, and mode of the individual household data. Ask students to construct a graph showing individual household variation in water usage.

Is it likely that some of the "heavy" use families wasted water? How can you decide when water is wasted? What are some of the easiest ways to save water in and around the home? When you save water, do you save energy? Explain.

PURPOSE: To determine the hardness of a water supply.

LEVEL: Junior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Hougendobler, Nancy. Water - And Something Else, An Interdisciplinary Environmental Education Unit for Middle School. Broward County Florida Schools. ERIC: ED 085 229

Review with the class the well-known fact that the odor, taste, and even color of water from a faucet varies from place to place. Explain that this is caused, in part, by the different minerals dissolved in water. Explain that the film left in the basin after washing hands is the result of soap reacting with minerals in the water, particularly compounds containing calcium, magnesium, and iron. Water containing high quantities of these substances is called "hard" water; water that doesn't contain these substances is called "soft" water.

ACTIVITY: Involve the class in testing the hardness of their water supply and comparing it with water hardness in other states by using the following procedure suggested in the reference cited above. Test, also, rain water to determine its hardness. Ask a student to research how water softeners work and report findings to the class. Try to determine if water softeners are used to save money or for other reasons.

In this investigation you will compare the hardness of the water you and your family use with water hardness in other states of the United States.

MATERIALS:

tap water	test tube
liquid soap	graduated cylinder
medicine dropper	cork

water-hardness chart (see following page)

PROCEDURE:

Pour 125 milliliters of tap water into a clean, dry test tube. Add 10 drops of soap solution to the water in the test tube. Put a cork into the mouth of the test tube.

Shake the test tube vigorously. Then permit the test tube to remain undisturbed for approximately 5 minutes. Are the soapsuds still visible? If not, add another 10 drops of liquid soap to the water in the test tube. Follow this procedure until the soapsuds are visible after the water has remained undisturbed for 5 minutes. To convert your results to water hardness in parts per million (ppm), multiply the number of drops of soap that you added by 20. Using the table on the following page,

compare the hardness of water in your community with other areas in the United States.

WATER HARDNESS IN THE UNITED STATES

State	Hardness (ppm)	State	Hardness (ppm)
Alabama	0-60	Montana	121-180
Alaska	61-120	Nebraska	180+
Arizona	180+	Nevada	121-180
Arkansas	0-60	New Hampshire	0-60
California	180+	New Jersey	61-120
Colorado	61-120	New Mexico	180+
Connecticut	0-60	New York	0-60
Delaware	0-60	North Carolina	0-60
Florida	180+	North Dakota	180+
Georgia	0-60	Ohio	121-180
Hawaii	0-60	Oklahoma	180+
Idaho	121-180	Oregon	0-60
Illinois	121-180	Pennsylvania	61-120
Indiana	180+	Rhode Island	0-60
Iowa	180+	South Carolina	0-60
Kansas	180+	South Dakota	180+
Kentucky	121-180	Tennessee	61-120
Louisiana	61-120	Texas	121-180
Maine	0-60	Utah	180+
Maryland	0-60	Vermont	0-60
Massachusett	0-60	Virginia	0-60
Michigan	121-180	Washington	0-60
Minnesota	180+	West Virginia	61-120
Mississippi	0-60	Wisconsin	121-180
Missouri	121-180	Wyoming	180+

PURPOSE: To examine the historical variation of rainfall in a geographic region.

LEVEL: Junior high school

SUBJECT: Mathematics

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

ACTIVITY: Assign to one or two students the task of visiting a local weather station which has been operating for many years. Ask that they bring back to class rainfall data obtainable from weather station records for the past 20 or so years. They should secure not only total annual rainfall for these years, but monthly totals as well. If a personal visit is impossible, ask a student to write for such available data from the nearest U.S. Weather Bureau station.

Present the data to students and ask that they work in pairs (preferably with the aid of a hand-held calculator) to calculate average rainfall per year, avarage rainfall per month. Calculate also the percentage of deviation above and below the averages present in the wettest and driest years and months. Graphing the data may be appropriate.

What, if any, patterns of rainfall appear to be present in the records? Is it likely that the area will ever again be as wet or dry as it was during the years used in this inquiry? Is the community prepared for very heavy rainfall or very severe drought?

PURPOSE: To study the erosive power of running water.

LEVEL: Junior high school

SUBJECT: Mathematics
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Rockcastle, Verne N. Water Wonders. Cornell Science Leaflet, V61, n1, 1967.

ACTIVITY: In the spring or after heavy rains creeks and rivers are muddy with sediment from upstream erosion.

Ask students to collect from different streams or rivulets a uniform sample, such as a quart or gallon, of muddy water. Working in teams of two or three, have students filter their muddy water samples through dry paper toweling that has been weighed. Dry the towel containing the sediment and reweigh. Calculate the weight of eroded material carried by a gallon of water.

Obtain from the nearest United States Geological Survey office (often listed in the telephone directory) the rate of flow of the nearest stream they measure in the watershed from where the samples were taken. Since one cubic foot contains about eight gallons, the class can calculate, roughly, the amount of soil carried away daily.

Is this of concern to farmers? To city dwellers? What, if anything, can be done about the problem?

PURPOSE: To show how water transportation affected the settlement of North America.

LEVEL: Junior high school

SUBJECT: Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

ACTIVITY: Obtain maps showing the population centers in North America for periods through the 17th through 20th centuries. Have students answer the following questions:

1. In the 17th and 18th centuries where was most of the immigrant (as compared to the native Indian) population located?

2. Why did Cincinnati and St. Louis grow faster than other cities in those areas? Name some of the early cities founded on the Ohio River; Mississipi River.

3. Why was St. Louis known as the "Gateway to the West"?

4. What major change to American society occurred in the 1870's and greatly reduced the importance of waterways on travel?

5. Name the present five largest cities in the United States; the world. Are they all located on bodies of water?

PURPOSE: To consider the impact of water shortages on life style.

LEVEL: Junior high school

SUBJECT: Social Studies

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: The Christian Science Monitor, March 18, 1977

ACTIVITY: In an article entitled "Coping With a Water Shortage," a Monitor correspondent in northern California reports that residents are taking actions such as the following to reduce water consumption in their drought-stricken area:

1. Placing brick sized or larger plastic bags in toilet tanks to reduce the seven gallons of water used each flush.
2. Reducing time spent under the shower to save some of the 40 gallons used in a typical five-minute shower.
3. Saving bath and/or soapy laundry water to use for toilet flushing.
4. Saving clear rinse water from the washing machine to water plants or shrubs.
5. Reducing drastically the use of automatic dishwashers and garbage disposals.
6. Washing automobiles by hand with very small amounts of water and a grease solvent.

Engage the class in discussing the seriousness of a drought that forces such actions. Are such actions new in America? Why or why not? Would such conservation practices "make sense" in a part of the U.S.A. that has abundant rainfall? Why or why not? Are students personally willing to undertake such practices voluntarily?

PURPOSE: To examine relationships between urbanization and stream flooding.

LEVEL: Junior high school

SUBJECT: Social Studies
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

Urbanization has greatly increased the amount of rainfall that runs directly into streams. Sidewalks, parking lots, streets, and building roofs are all impervious to rainfall. The water dropped during heavy rainstorms is not retained by trees, grass, or absorbent soil as it was in earlier times when the site of present cities was primarily forested or agricultural land. There is evidence to suggest that in highly urbanized areas a three-inch rainfall today can cause as much flooding as a six-inch rainfall caused in earlier times. The more frequent and more serious flooding occurring in streams below large urban centers today often produces disastrous consequences on trailer parks and other low-cost housing located on flood plain land.

ACTIVITY: Engage the class in calculating the area of impervious material on (1) their school ground, and (2) their home or apartment site. Calculate the volume of immediate run-off water that would be discharged from their school and home land during a five-inch rainstorm. Trace the flow of this run-off water into collecting streams and ultimately a river.

Discuss, with input from a specialist from the city sanitation department or from the city planning commission what, if anything, can be done to reduce rapid water run-off from an urban area. Discuss with the same resource person what, if anything, can be done to reduce flood damage in flood plains below the city. Why isn't more being done?

PURPOSE: To review important uses of clean water.

LEVEL: Junior high school

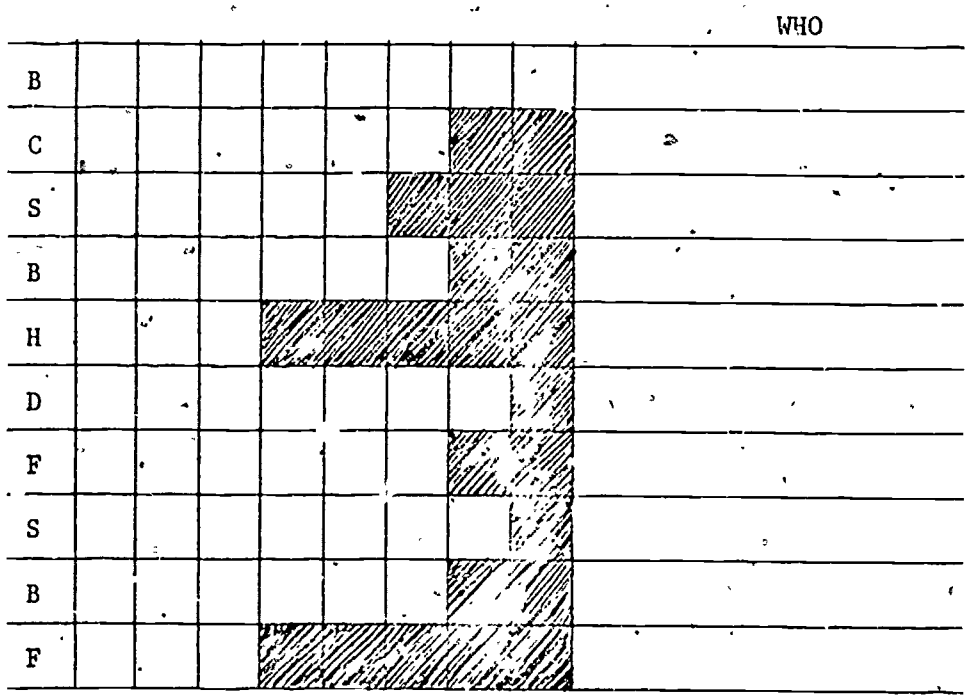
SUBJECT: Language Arts

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Water Pollution. A Unit Developed by the Environmental Education Project Staff, Topeka, Kansas Public and Parochial Schools. ERIC: ED 097 217

ACTIVITY: Use the puzzle shown below according to the directions given.

CLEAN WATER USE PUZZLE



OKOCGIN	SWMMGNII	RDGNIKNI	TAOBGNI	SGHNFII
EHMO	HTAEBRNIG	GNIBTHA	IGNISK	DOFO

1. Each scrambled word fits into one of the lines above.

2. Each word represents a use or need that people and/or wildlife have for water.

3. The first letter of each word has been placed in the first block to aid in getting the proper word. There is one block for each letter of the word.

4. The last column labeled "WHO" is used to identify who uses (or needs) the water in the particular way that the word describes. Example: If you had the word "FOOD" then you would write "people and wildlife" in the "WHO" column.

PURPOSE: To examine the possibility of electrical production from tide action.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

REFERENCE: Walker, Harry O. Energy: Options and Issues. Davis, California: The University of California, 1977.

The possibility of utilizing the rhythmic tidal motions of the oceans has attracted man's interest for centuries. Attempts to harness the massive quantities of energy contained in tides have not been utilized on a large scale. Of the difficulties surrounding this energy source, there are five major concerns:

1. Tidal power plants are site specific. In North America, only two sites appear feasible. The Passamaquoddy Bay Area north of the United States-Canadian border has an estimated potential of 1,800 magawatts. Another site in Knick Arm of Cook Inlet (Alaska) has potential for 9,500 megawatt production. Both sites are favorable for power generation due to small inlets and large bay areas.

2. Tidal production areas are located distant from energy consumption centers. Transmission from the Passamaquoddy Bay Area is feasible; Anchorage, Alaska would be the only logical site to use Cook Inlet power.

3. Because the arrival of each high tide occurs 25 minutes later than the previous tide, a problem of phasing the periods of generation to the periods of energy needs arises. Some plans for air or water power storage to match supply and demand exist.

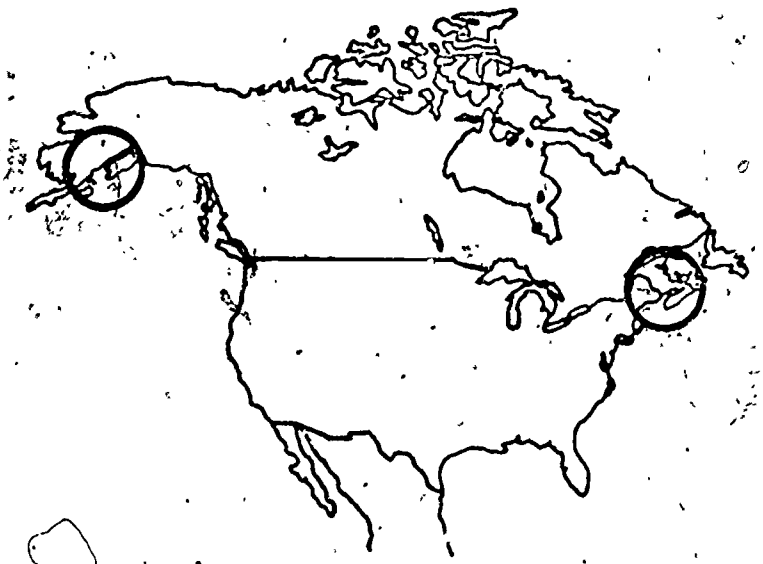
4. The generating systems would have a large capital investment per potential kilowatt. The construction and maintenance of devices in demanding environments is a problem.

5. Possible adverse environmental effects have to be considered. Although thermal pollution would not be a problem, interference with the movement of marine species is of concern.

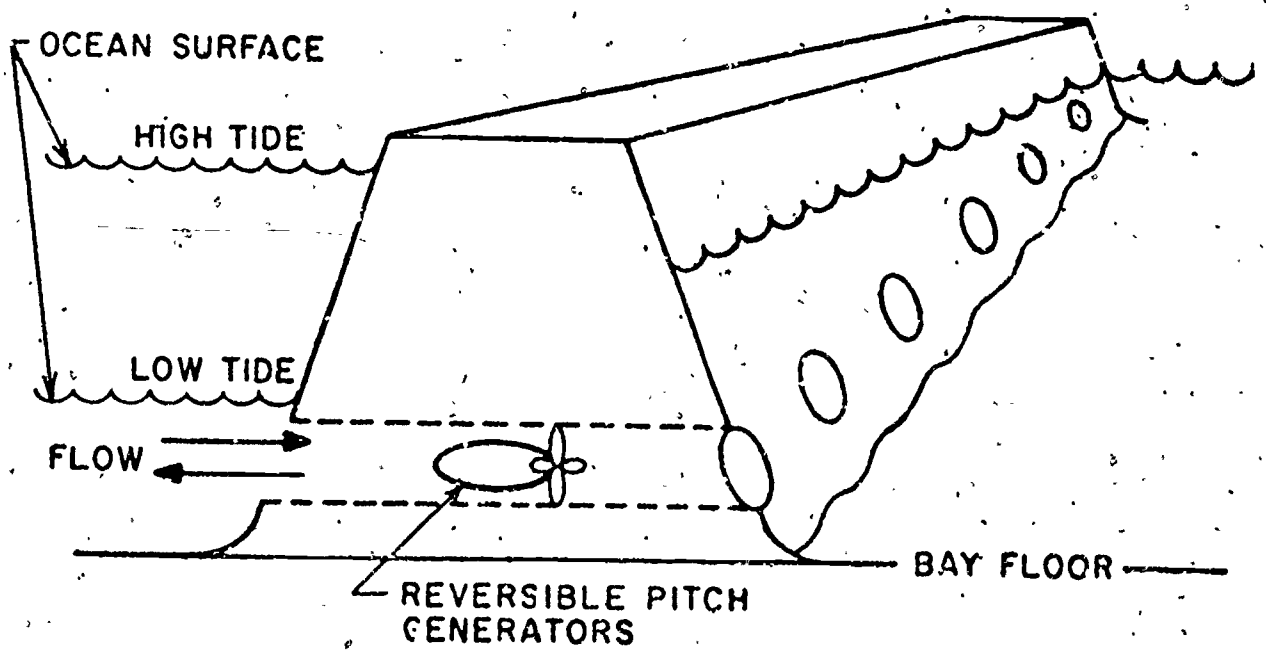
At the present time, energy cost does not encourage development of this system. Future increased energy costs may encourage development of tidal power electrical energy. A model of a tidal power generator is shown.

ACTIVITY: Suppose both generating plants (Passamaquoddy Bay and Cook Inlet) were built. Would the amount of electricity produced

be a significant contribution to present U.S. total production of electrical energy? Should U.S. general tax funds be used to build such projects that would provide power for very limited areas?



Tidal power unit sites



Tidal power unit schematic

PURPOSE: To stress the importance of feedlot waste product control.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Water Pollution. Environmental Education Curriculum. Topeka, Kansas Public Schools. ERIC: ED 097 217.

1971 EQ Index. National Wildlife Federation, Washington, D.C. ERIC: ED 59 073

Waste water run-off from animal manure in feedlots into streams is serious; vaporized ammonia can overdose lakes a mile away with nitrogen.

Waste Equivalence

1 cow	= 16 people
1 hog	= 2 people
7 chickens	= 1 person

The Environmental Protection Agency (EPA) now requires federal permits for feedlot operations of over 1000 animals. Feedlots are of particular environmental concern because (1) the wastes of many animals are concentrated in a small area, and (2) most feedlot waste does not go through sewage treatment.

ACTIVITY: Discuss the following questions: What is a feedlot? Where are feedlots found? Are feedlots a cause of water pollution? Do all feedlots pollute?

Compare the concept of a feedlot with 1000 cattle with 1000 cattle grazing on a 5000 acre range. Why is the feedlot more potentially harmful to water quality?

PURPOSE: To show that water can be boiled at room temperature.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

Pure water boils at 100°C. at sea level. Atmospheric pressure at sea level is defined to be the air pressure that will support a column of mercury 76 cm. tall. Air pressure can be thought of as a force per unit area which is pushing down on the earth. To boil, water must be given energy (by heating) to overcome the air pressure and cohesiveness among water molecules.

An alternative way of boiling water which does not involve heating is to reduce the air pressure. If the air pressure is sufficiently reduced, water will boil at room temperature. This phenomenon is evident in high altitudes; the reduced air pressure is responsible for the fact that water boils at temperatures less than 100°C.

ACTIVITY: Place a small beaker of room-temperature water under a bell jar on a vacuum pump. The edges of the bell jar should be coated with vaseline to insure a good seal. Start the vacuum pump. After a few minutes the water should start to boil.

Ask the students to explain the phenomenon. Some may believe the water is heating--the experiment can be carried out with a thermometer in the water.

Pose this question to students: If reduced air pressure lowers the boiling point of water, what will increased air pressure do to the boiling point? Water is often heated above 100°C. in pressurized systems for use in mining sulphur. This process is known as superheating water. Some students may be interested in researching the use of superheated water.

PURPOSE: To become aware of the wide range of water pollutants discharged from American homes.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: "Water in New Mexico" EPA/Citizen Information Exchange Program, No. 3, August 1975.

ACTIVITY: Remind the class that not all household wastes are placed in the garbage can. The kitchen sink, the toilet bowl, and the lavatory are used by many persons for disposal of liquid substances used in and around the home. Present to the class by means of an overhead transparency or duplicated handout the following list of common household substances and the toxic substances they contain.

Antiseptics: carbolic acid, alcohol, hexaclorophene
Astringents: alcohol, zinc chloride
Bleach concentrate: sodium hypochlorite
Bowl cleaners: caustic alkali or hydrochloric acid
Bubble bath: Polyphosphates or aryl sodium sulfonates
Charcoal starter: pertoleum naptha
Cleaning fluids: chlorinated hydrocarbons
Cosmetic liquids: mineral oil
Deodorant lotion: aluminum chlorhydroxide
Detergents: surface active agents
Disinfectants: pine oil, phenol
Floor wax liquid: petroleum naptha
Furniture polish: petroleum solvents
Metal polish: petroleum solvents
Mouth wash: thymol, boric acid, menthol
Pesticides: organophosphates, chlorinated hydrocarbons
Rat poison: arsenic, phosphorous, warfarin
Rug shampoo: alkyl sodium sulfate
Shampoo: polyphosphates
Suntan oil: menthol and salicylates
Weed killers: 2,4,d or phenyl mercuric acetate
Wood preservatives: chlorinated solvent
Vinegar: acetic acid

How many of these substances are being used in students' homes? How many of these substances are dissolved and not likely to be removed in a sewage treatment plant? Is the small amount of discharge of these substances from one household really something to worry about? Why or why not? If such substances shouldn't be flushed out of the home, what other means of disposal are available? Is this practical? What makes something "practical"?

PURPOSE: To stress that serious diseases can be transmitted in impure water.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Water Quality Unit. Edmonds School District 15, Lynnwood, Washington, 1974. ERIC: ED 099 237

The following chart describes some of the serious water-borne diseases and information about them.

Disease	Incubation Period	Case Fatality
Typhoid	1-3 weeks	2-10%
Paratyphoid	1-10 days	High (infants, aged)
Cholera	2-3 days	75% in epidemics
Leptospirosis	4-19 days	High among aged

ACTIVITY: Ask students to research water-borne diseases to find fatality rates and immunization procedures. Look for statistics concerning the rate of incidence of the diseases in the United States and world-wide. Why is the rate much lower in the United States? What are some procedures regularly taken in the United States to protect against water-borne diseases?

PURPOSE: To investigate factors affecting rate of water evaporation from free-water surfaces such as lakes or reservoirs.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

It is common knowledge that water evaporates slowly from its surface into the air. Common sense also suggests (1) that wind blowing across the surface of a body of water increases the rate of evaporation, and (2) that warmer bodies of water will evaporate faster than cold ones. Air pressure and humidity also influence rate of evaporation.

ACTIVITY: Secure from the National Weather Service information about the evaporating pans which they use to measure rate of evaporation. These pans are simply circular containers about five feet in diameter, and ten inches deep. The device also includes a thermometer to measure water temperature and an anemometer to measure wind speed. Conceivably, a weather service station might have a pan they would loan to the school--if not, acceptable components needed to make an evaporation pan should be easily available in most schools.

When the pan is operable, assign teams of students to collect the following data daily over a period of several weeks--preferably in early fall or late spring, when some days are likely to be hot: fractional inches of evaporation; water temperature, atmospheric temperature, wind speed, air pressure, and humidity. Develop a table or matrix to examine the interrelatedness of these factors.

National Weather Service data indicates that evaporation from shallow lakes in the United States ranges from about 25 inches per year in climate such as found in Maine to more than 80 inches in the very hot and dry southwestern U.S.A. Does the collected data fall within this range? Why is it likely to be higher? Using an extrapolated figure of amount of water that evaporates per year for your area of the United states between the extremes of 25 inches in Maine and 80 inches in Arizona, have students calculate the amount of water that evaporates yearly from the largest lake in their community or state.

PURPOSE: To investigate a possible future source of fresh water.

LEVEL: Junior-senior high school

SUBJECT: Science
Social Studies

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

REFERENCE: The Iceberg Cometh. Newsweek, July 4, 1977, p72.

Icebergs, due to the fact that seawater as it freezes releases its salt content, are potential sources of billions of gallons of fresh water.

The feasibility of towing icebergs from Arctic regions to areas in need of water has been proposed but as of now has not been attempted. A proposal now being considered by oil-rich Saudi Arabia is to bring a 100 million-ton rectangular glacier 1 mile long, 1,000 feet wide, and 900 feet deep from Antarctica. The plan involves wrapping the iceberg in plastic to reduce the melting; still the 6 to 8 months would cause 20% of the iceberg to melt. Even with the $90 million cost, some believe that the iceberg water would be less expensive than water from desalination plants.

ACTIVITY: Find other articles on iceberg towing in science journals. Do icebergs appear to be a viable source of fresh water? Might the removal of icebergs from Arctic areas affect the ecosystem of that area? How much effort shoul' be made to bring fresh water to areas of the world that are "naturally" dry? Should the "melting icebergs" source of fresh water be considered a promising idea for water-hungry Southern California?

PURPOSE: To stress the impact of thermal pollution on bodies of water.

LEVEL: Junior-senior high school

SUBJECT: Science
Social Studies

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Murphy, James E. Water Pollution, Part 1 - Background. Science Activities, January, 1972, pp41-45.

Thermal pollution of bodies of water is a serious problem. Heat which is often discharged from waters and irrigation waters can dramatically affect aquatic plant and animal life.

Temperature is important to aquatic organisms because it regulates or limits the biochemical reactions within their bodies. In general, colder water suppresses chemical activity and warmer water accelerates it. Plant life may enjoy longer growing seasons or migrate into previously inhospitable water due to warmer water conditions.

The temperature can also affect the relationship between organisms. For example, fish eggs in warmer than usual water will hatch in early spring, long before any natural food is available. Rapid changes in temperature are also an internal physiological disaster to animals accustomed to the gradual change of seasons.

For these reasons, it is recommended that heat added to a freshwater stream not exceed that which would raise the water temperature more than 5°F. durint the minimum daily flow. In lakes, a 3°F. increase in water temperature should not be exceeded.

A rapid indicator of the thermal environment of a body of water can be obtained through the analysis of fish species in habitation. For some species of fish, the maximum compatible temperatures are provided:

93°F.	growth of catfish, gar, white or yellow bass, spotted bass, buffalo, carpsucker, threadfin shad, and guzzard shad;
80°F.	spawning and egg development of catfish, buffalo, thread shad and guzzard shad;
55°F.	spawning and egg development of salmon and trout, except lake trout;
48°F.	spawning and development of lake trout, walleye, northern pike, and sauger.

As the table points out, the fact that many fish can live at a higher water temperature than at which they can reproduce can explain the gradual disappearance of a species.

In some localities, thermal pollution has greatly altered the ecosystem of a body of water. The Mahoning River in Ohio, used to cool Youngstown steel mills, for example, has been as hot as 117°F.

There are solutions to this problem. Closed circuit water systems have been built for power plants. The Environmental Protection Agency (EPA) now requires cooling towers for new power plants on Lake Michigan.

ACTIVITY: Discuss the following questions: What is thermal pollution of water? Why is it a serious problem? What types of industry are the worst thermal polluters? How can thermal pollution be alleviated? Is it "fair" to require power companies or steel plants to build and use closed circuit water systems that are expensive just to save some fish?

PURPOSE: To propose the creation of a student organization which monitors water quality.

LEVEL: Junior-senior high school

SUBJECT: Science
Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Offutt, Thomas W. Students in a Water-Testing Program. The Science Teacher, January, 1975, pp45-46.

In October, 1972, Congress passed into law a bill which amended the Federal Water Pollution Control Act. Much attention has centered on the punitive aspects of the act with little notice made of its pervasively constructive theme. Provisions in the first section of the Act mandate public participation. The Act also requires states to submit annual inventories of water quality and to conduct a statewide monitoring program.

In Ohio, for example, a program by which students and their teachers from areas around the state use university equipment to regularly test water quality in their localities has been developed. Data collected is not to be used in litigation but serves as an early warning system.

ACTIVITY: For this activity to be a success, you, the teacher, or another adult must first of all be interested. The initiation and maintenance of the program will depend on your interest.

If you are interested in sponsoring a group of students, contact your local university or the EPA for their guidance. The journal article cited above provides additional information about the program described in this activity.

PURPOSE: To examine the reduction of marshes and swamps in the ecosystem.

LEVEL: Junior-senior high school

SUBJECT: Science
Social Studies

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

Much productive farm land in the United States has been developed from swamp land which was drained by elaborate systems of tiling and ditches. Land developers in South Florida, near San Francisco Bay, near the Great Dismal Swamp in Virginia, and in many other places have used massive filling operations to create highly valued building sites for homes and apartments. In fact, coastal swamps and marshes are often regarded as wasteland to be filled in or drained for useful purposes.

ACTIVITY: Ask several students to research the importance of swamps and marshes in natural ecosystems. One student, for example, might focus on the importance of such places for waterfowl, another on the role of the Everglades in the shrimp fishing industry in the Gulf of Mexico, another on the life cycle of several commercial varieties of ocean fish who start their lives in shallow coastal waters. Ask a student or two to research the importance of swamps and marshes in providing areas for natural storage of water and later slow release, in regulating stream flow, in preventing floods, and in keeping water tables high.

After students report on their findings to the class, involve the total group in discussing issues such as the conflict between what might be most profitable in the short run to a farmer or land developer but not in the best interest of the community in the long run. Since marshes are notorious as breeding places for mosquitoes, wouldn't it be a good idea to drain all of them? Who should make the final decision on a question such as this?

PURPOSE: To provide an accurate accounting of the water used in household activities.

LEVEL: Junior-senior high school

SUBJECT: Science
Mathematics
Social Studies

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: Leydon, Michael B. Domestic Oases: A Study of Household Water Use. Science and Children, January-February, 1973, pp17-19.

ACTIVITY: A fairly accurate accounting of the water used and the ways in which it is used in a household can be made by maintaining "use sheets." On the sheets, the major appliances of water usage are listed and the frequency of use is indicated.

The capacity of a dishwasher or washing machine can be determined by measuring the drain-off. Sinks and toilets can be filled to their normal levels with pre-measured water. To measure the water used in the bathtub, a piece of tape can be attached to the side and calibrated as pre-measured water is added. When the bathtub is used, the amount is recorded on the "use sheets." For showers, the bath drain is closed until the shower is completed and quantity of water noted.

By keeping accurate "use sheets", the quantity and ways in which water are used can be determined. Bar graphs may be constructed to represent the quantity of water used in the various ways over a week's period.

For those students living in city water districts, there is an easy check of the accuracy of their water accounting. Before and after the study, note water meter readings. Readings may be in cubic feet of water which will be converted to gallons. If the meter does not indicate the unit of measure, contact the water department to obtain this information.

Why will the volume of water indicated by the meter usually exceed the amount accounted? What are some of the uses of water which were not recorded on the "use sheets"?

If a large discrepancy between the "use sheet" and meter amounts occur, students should be encouraged to investigate for the cause. Was it due to faulty accounting, or are there leaky faucets or a toilet that is not functioning properly? Improperly functioning water softeners can also use large quantities of water.

Using the data from the "use sheets" or water meter readings, have the students calculate the amount of water their families use in a year. Using the average amount of rainfall and the surface areas of their homes, have students calculate the amount of water striking the roofs of their homes and compare this to the amount of water they use.

PURPOSE: To examine conflicts inherent in obtaining city water supplies.

LEVEL: Junior-senior high school

SUBJECT: Social Studies

CONCEPT: In water management, as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

Many growing cities face impending water shortages. Patterns of growth and patterns of water usage indicate the need to develop additional water resources within the next several years to avoid serious water problems before the year 2000.

In many midwestern states city water supplies are drawn from lakes or reservoirs formed by damming streams or rivers. Proposals to build another dam to assure a city's water supply for future years are supported or opposed strongly by various groups who will be affected by such projects.

ACTIVITY: Indicate to the class that a large city nearby is proposing to build a dam to increase its water supply.

Ask individual or small groups of students to volunteer to play the roles of various groups of persons such as the following who support or oppose the project:

(1) The City Chamber of Commerce personnel who argue strong that an assured water supply is critical in attracting new industrial and commercial developments.

(2) Construction firm workers who believe the project will provide several hundred jobs.

(3) The farmers who will lose their land.

(4) Water ski enthusiasts and sailboaters who believe present lakes are becoming overcrowded.

(5) The treasurer's office in the county where the lake will be formed who objects to losing the taxes now being paid by farmers who will be displaced.

(6) City water and sewage department personnel who argue strongly that new water supplies will be needed.

(7) A county agricultural agent who believes the area is losing far too much of its good farm land for uses other than raising food.

Have each individual or group assemble facts and arguments and present their point of view to the class. Provide opportunity

for "cross-examination" of each presenter's position.

Finally, ask the class to vote to decide whether the dam should be built.

PURPOSE: To study man's use of flowing water to produce electrical energy.

LEVEL: Junior-senior high school

SUBJECT: Social Studies

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

REFERENCE: The World Almanac. New York: Newspaper Enterprise Association, Inc., 1977.

Within the last ten years, the amount of hydroelectric energy produced in the United States has remained at a near constant 15.5% of the total electricity produced. Since the consumption of electricity has been increasing annually, new hydroelectric facilities are being proposed.

ACTIVITY: Have students divide into two teams. One group will support the building of a hydroelectric facility along with the necessary accompanying reservoir. The other group will oppose the hydroelectric facility because of the environmental destruction it will cause. Have each group research the social, economic, recreational, and aesthetic aspects of the proposed dam and reservoir.

A debate may be held in which the teams present their arguments.

PURPOSE: To examine efforts to preserve wild and scenic rivers.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water has recreational, aesthetic, cultural, and inspirational values which contribute to the quality of human life.

ACTIVITY: Secure from the Sierra Club, the Audubon Society, or some local sportsmen's club a film that depicts a beautiful wild or scenic river. Many students will identify vicariously with activities such as canoeing (especially in white water), fishing, camping, and viewing wildlife found along rivers typically shown in such films.

Invite a knowledgeable person from the Sierra Club or someone who has been active in opposing dam construction and/or stream channelization project to come to the class. Ask the resource person to review with the class the process by which a river can be "saved" as a wild or scenic river. Ask that they review, also, efforts being made in your state or in neighboring states to save rivers or free-flowing streams. What arguments can be advanced in favor of such action? Typically, what general types of persons are for or against such action? What can be done on an issue of this type by a citizen who wants to become involved? What, if anything, can be done by school-age children?

PURPOSE: To understand one dimension of the water quality problem in Lake Erie.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water is not unlimited; therefore, wise water management is essential to our continued social progress.

REFERENCE: The Cause of Pollution in Lake Erie. In Water Quality in a Stressed Environment (Readings in Environmental Hydrology). Edited by Wayne A. Pettyjohn. 1972.

Several large cities in the Lake Erie drainage basin have combined sewer systems that carry both sewage and water that drains off of the surface during periods of heavy rainfall. The sewage systems are designed to handle all sewage during normal weather, but during a particularly rainy period most of the combined rain run-off and sewage is discharged untreated directly into the lake. The cities of Detroit, Cleveland, and Toledo are reported to dump, from their combined sewer systems, billions of gallons of untreated sewage into Lake Erie.

ACTIVITY: Engage the class in considering why it is more expensive to build separate systems for surface water run-off and sewage, rather than a combined system. Have students heard of places where sewage has backed up into homes during periods of very heavy rainfall? What causes this condition? If a city built a combined system that was satisfactory 75 years ago, is it "fair" to require that they modernize it today? Should the cost of modernizing be borne by the city or by someone else? Who? Why?

Finally, examine how sewage is disposed of in the students' community. Is it adequate? If inadequate, what is being done to correct the condition?

PURPOSE: To become aware of conflicting demands for limited water supplies.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

ACTIVITY: Assign to a small group of students the task of researching the importance of Southern California in our national life. The agricultural productivity of the Imperial Valley, the concentration of aerospace industry, the millions of persons living in the Los Angeles-San Diego corridor, and similar factors will be noted. The dependence of Southern California on water imported from the Colorado River should also be noted.

Assign to another small group the task of researching at the same time, the importance of the Columbia River basin in our national life. The development of the aluminum industry that depends on cheap hydroelectric power generated at the many dams across the Columbia river, the irrigated fruit producing areas near Yakima, the salmon industry, and many similar factors will be noted.

The shortage of water available to Southern California from the Colorado River and the huge amount of water flowing through the Columbia has resulted in groups of Californians urging that a huge, very expensive system be built to transport water from the Columbia River to Southern California.

Ask the "Southern California group" to present the strongest possible case they can in favor of the proposed irrigation system. Ask the "Columbia River group" to present their case, opposing the system. After listening to the presentations, involve the class in voting on whether they favor or oppose the idea. Discuss the difficulties involved in settling intra-state disputes. What role, if any, should the federal government play in such disputes?

PURPOSE: To examine the extent to which amounts of rainfall dictate agricultural practices.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water quality and availability directly affect the physical environment, healt and all human institutions and activities.

ACTIVITY: Review with the class a climatological map that shows inches (or millimeters) of average rainfall per year. Note that the most productive farmland in the United States, e.g., Indiana, Illinois, Iowa, tends to receive about 40 inches per year, with much of the rain falling during the growing season. Locate the areas in the United States, Africa, and Asia that receive less than 20 inches per year. With this limited rainfall, cultivation of crops such as corn and soybeans is impractical. However, seasonal growths of grass can support flocks or herds of grazing animals that "follow the grass." As long as the rancher or nomad keeps his number of livestock within the limits that the semi-arid ecosystem will support continuously, he is making the most productive use of the resources nature provides in such lands.

Engage the class in discussing questions such as the following:

1. Is it possible to ruin marginal grass lands by overgrazing?
2. Is it likely that privately owned or publicly owned grass lands are more likely to be overgrazed? Why?
3. How would you proceed to establish a "fair price" to charge cattlemen or sheep men for the right to graze their animals on National Forest Lands in our western states?
4. How would you proceed to determine the number of animals permitted in a given area? Would this number vary from year to year? Why?

PURPOSE: To examine a problem associated with agricultural irrigation.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water is not unlimited; therefore, wise water management is essential to our continued social progress.

REFERENCE: The Christian Science Monitor, March 31, 1977.

Review with the class the rather surprising fact that irrigation is spreading faster in Nebraska than in any other state. Indicate that much of the water used to irrigate crops, particularly corn, comes from deep wells that farmers have drilled on their properties. Hydrologists are certain that farmers are taking up water from the underground natural storage areas much faster than the natural recharge rate. This condition, unless corrected, must eventually result in no irrigation water available from these wells (Such a condition has already occurred in sections of Texas' Panhandle where wells have been overpumped for many years.)

ACTIVITY: Discuss as a total class or in small groups questions such as the following which may require legislation and/or court decisions in the future. Who owns underground water, the state or the surface landowner? Should permits be required before farmers can drill irrigation wells on their properties? Should meters be placed on farmer-owned wells to regulate the amount of water that may be pumped from them? If certain agricultural practices such as leaving more crop residue on the soil for mulch and avoiding overtilling could reduce significantly the amount of water required to grow a crop, should the State have the power to require such practices? Why or why not?

PURPOSE: To examine the influence of large-scale developments on ground water supplies.

LEVEL: Junior-serior high school

SUBJECT: Social Studies
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Brown, Lester R.; Patricia L. McGrath; Bruce Stokes. Twenty-Two Dimensions of the Population Problem. Worldwatch Paper #5. 1976.

Review with the class the commonly used practice of obtaining a water supply by the process of drilling a well into underground water-bearing layers of gravel, shale, or rock. In past times a cheap, pure, and plentiful supply of water could often be obtained from wells drilled to a depth of 50-150 ft. It is possible, however, to pump out of an underground water table (aquifer) more water than natural processes put into it. The booklet referenced above reports, "In Polk County, Florida, the water table fell 21 feet in recent years, as the giant amusement park Disneyworld and other developments drew new residents into the area. Local scientists predict that if the county's population grows 50 percent in the next decade, as expected, 'catastrophic water shortages' will develop."

ACTIVITY: Engage the class in discussing questions such as the following:

1. Who "owns" and/or should own the underground water in Polk County, Florida (or in their home area)?

2. Should action be taken to halt further drop in the water table level? What kind? By whom?

3. Who is "responsible" for developing water problems such as that surrounding Disneyworld?

Try to personalize more fully the problem cited above by asking a student or two to discuss with a local well-driller (a) whether the local water table level is falling, and (b) what suggestions he has for solving the problem around Disneyworld or wherever the water table is falling rapidly.

PURPOSE: To encourage student involvement in the location and abatement of water pollution problems.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: There is much individuals, families, and larger social groups can do to conserve water and to improve water quality. It is to everyone's advantage to develop and practice these skills.

REFERENCE: Burke, Kevin. A Social Approach to Environmental Science. Science Activities, June 1973, pp36-37.

ACTIVITY: For a homework assignment, students can be asked to obtain water samples from ponds, streams or rivers that may contain chemical or bacterial pollution. It may be helpful to provide students with the following information: metal plating industries often release cyanide; electrical device, paint, and pesticide manufacturers are sources of mercury; and industrial, domestic, and agricultural sewage outfalls frequently contain nitrates or nitrites.

After a number of water samples have been collected, the samples may be analyzed for contaminants. The Pollution Detection Kit by Damon provides an instruction booklet and materials required to test for ammonium, copper, cyanide, hydrogen sulfide, lead, mercury, oil, pH level, bacteria, and sulfur dioxide. (A guide to water testing equipment appears on page 148.) Groups of students may be given several water samples to analyze and be asked to prepare written reports concerning contaminants.

If samples are found to contain significant contaminants, the class should decide on the action to be taken. Should letters be written? Should the person(s) responsible for the pollution be notified before the newspaper or the Environmental Protection Agency? One seventh grade class' response is reprinted in Burke's article cited above.

Understandably, many students will feel resentment toward water control officials and manufacturers, feeling that inaction on their part is responsible for the condition of the water. In order to provide another perspective on the problem, the simulation game Dirty Water may b[illegible]sed.

In the game, students assume the role of a water pollution control official facing the task of keeping local bodies of water in a normal state of ecological balance. While the major sources of water pollution are often industries, players discover that it is neither wise nor possible to restrict all industrial wastes. Establishment and enforcement of water

pollution and control measures are costly, hence students must deal with financial problems. The winner is the student who most effectively anticipates pollution control problems, prevents the overpopulation of aquatic species, manages finances efficiently, and counters pollution originating out of his jurisdiction.

Experience with the game will provide students with a feeling for the magnitude and complexity of water pollution problems. With the new information provided from the simulation game, students may draw conclusions as to the pollution problem which they found in their analyses of the water samples.

PURPOSE: To examine the nature of water pollution problems in developing countries

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Pollution--Nemesis of the Third World: The Christian Science Monitor, July 13, 1977, pp16-17.

Bring to class and/or involve students in bringing to class pictures from the National Geographic magazine or other magazines or sources such as the one cited above that show how people in the African desert countries or in underdeveloped areas such as rural India or Malaysia obtain their drinking water. Typically, it may be hauled or dipped from an open well, poured in open jars or cans, and carried by women or children many yards or even several miles to their homes, where it is used for drinking and cooking. It is not unknown to have drinking water dipped from a river not far downstream from places where bathing and clothes washing is occurring. According to the World Health Organization, in 1975 only 22 percent of the people living in rural areas of developing countries have reasonable access to safe water. An even smaller 15 percent have adequate sanitation. A majority of rural dwellers do not have access to or choose not to use human waste disposal facilities such as outdoor latrines.

ACTIVITY: Engage the class in discussing what can or should be done to improve this situation. Does the developed western world have a responsibility to help improve this situation? If a drilled well for an Asian or African village seems to be a good idea to an American working in one of those countries on a U.S. Government aid project, is the idea necessarily viewed as a good one by the villagers? Should the pump be made in U.S.A. or elsewhere? Where?

After discussing such questions, invite a resource person such as a veteran who has served in an undeveloped country or a former Peace Corps member to come to class and react to class ideas. Finally, ask each member of the class to assume he is Minister of Health or Minister of Economic Development in an undeveloped country. He has the task of writing, in a page or two, his plan for improving the drinking water and sewage disposal systems for his country.

PURPOSE: To demonstrate the eroding power of water drops.

LEVEL: Junior-senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

Drops of water, which are nearly spherical in shape, have unusual penetrating ability because of water's high surface tension. While all liquids have some surface tension, that of water is unusually high because of the strong hydrogen bonds that join water molecules together. Thus a drop of falling water should "hit harder" than a drop of some "softer" liquid.

ACTIVITY: Develop a procedure for comparing the influence of drops of water and some other liquid such as glycerine when dropped on a soft erodable substance such as soap or chalk. Standardize, as much as possible, the size of the drops by using identical medicine droppers or pipettes for both liquids.

Discuss the weathering and/or eroding effects of storm-driven drops of water on soil and rocks. Discuss also the even stronger forces exerted by frozen water when it expands in rock crevices.

PURPOSE: To collect watershed data by use of a questionnaire.

LEVEL: Junior-senior high school
SUBJECT: Social Studies
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: A Curriculum Activities Guide to Watershed Investigations and Environmental Studies, Peter A. Gail, and others. Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106. ERIC: ED 104 651.

ACTIVITY: Engage the class or groups of students in developing a questionnaire to collect data concerning factors that may affect the quality of water in the area. Discussion on items to be included will likely lead to a list that contains several found in the sample survey on the next page.

Arrange questions so that you can get people expressing their feelings about their town or community, what they would like to see corrected, early in the interview. Save potentially sensitive questions such as where animal wastes are disposed for the end of the interview.

The skill of the student while interviewing the respondent is critical in determining the extent and quality of responses obtained. Have students practice under conditions they might face in the community. Role play with teachers, parents, or other students. Students should be prepared to deal with questions such as, "Why do you want to know this? How will this information be used? Will my name be used? Might this get me into trouble?" Suggest to students that, whenever possible, questionnaires be filled out at the door rather than being left for later pick-up.

After collecting the data analyze it for evidence of community attitudes toward water quality. A "letter to the editor" that summarizes findings and makes recommendations might be a culminating outcome. Or a report to the town council might be appropriate.

WATERSHED SURVEY

Good morning, Mrs. Jones. We are working to help you get improvements in the community that you feel are important. We are interviewing some of the people in our town to find out what they would like us to include in our report to the town council, and to get information to support the research some of our class members are doing. Any help you give us will be kept confidential. The report will be a summary of responses and won't mention any names.

1. What situations or problems concern you in our town?
2. How do you feel these could be corrected?
3. Do you have a garden? _____yes _____no
4. Do you use a fertilizer? _____yes _____no;what kind?
5. How do you di ose of raked leaves? grass?
6. Do you feel our town uses an excess of salt on our roads? _____yes _____no
7. Has the salt affected you car or driveway? _____yes _____no
8. Do you own a well? _____yes _____no
9. Is it presently in use? _____yes _____no; Has it ever been contaminated? _____yes _____no
10. Do you have a septic tank? Or tie in to the town sewer?
11. Does your basement flood? _____often _____occasionally _____almost never
12. Has your septic tank ever over-flowed? _____yes, often _____yes, once or twice _____no, never
13. Do you have a garbage disposal? _____yes _____no
14. Do you have a creek nearby? _____yes _____no
15. If so, are there any odor problems? _____yes _____no
16. Has your creek ever over-flowed? _____yes, often _____yes, once or twice _____no, not that I can recall
17. Has the over-flowing of the creek ever caused any damage? _____yes _____no
18. If so, what kind?
19. Do you own any pets? _____yes _____no
20. What kind of pets and how many?
21. How do you dispose of animal waste?
22. How do you dispose of your garbage? _____incinerator _____garbage truck _____outdoor burning

Name_____

Address_____

_____

PURPOSE: To examine a problem associated with irrigation.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

Soil scientists indicate that proper irrigation of arid lands is a difficult and complex task. It involves much more than just flooding or sprinkling the proper amount of water on growing crops. Improper sub-surface drainage and/or year-after-year evaporation of water from the surface of fields can easily result in salinization of the soil. As water evaporates it leaves behind the mineral salts found in it; in less than 50 years the surface of the land may contain so many salts that desirable crops cannot be grown. Large areas of land in Pakistand and India are in this condition. The soil can be reclaimed only by installing proper drainage systems and by using large amounts of water to leach out the excess salts. This removal of salts through drainage canals obviously reduces the quality of the water for subsequent use downstream.

ACTIVITY: Engage the class in discussing what action, if any, should be taken in the following case, and by whom:

A farmer in Nebraska or Texas or some similar semi-arid area has enough money to drill some wells to irrigate several hundred acres of his land, on which he can raise large crops of corn, wheat, or grass. He does not have enough capital to install the proper drainage system before he starts to use heavy applications of mineral-laden water on his fields. He is uncertain about the future of his water supply or the market price for his crops.

PURPOSE: To examine conflicting demands for use of limited water supplies.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

ACTIVITY: Review with the class the evolving United States energy plan that forsees greatly increased use of coal as an energy source during the next two decades. Review also the fact that the large strippable areas of low sulphur coal in the Great Plains area of the United States appear to be preferable to use rather than the deeper, higher sulphur coal of Appalachia.

Economists report that the most economical way of moving coal from the Great Plains to other parts of the country where it can be used to generate electricity is by pipeline. The coal can be ground into fine powder, mixed with water, and pumped through large pipelines just as oil is moved in this manner.

The Great Plains have inadequate rainfall for many agricultural crops and thus use extensive and growing amounts of water for irrigation. Water used to pump coal to the East or South obviously would not be available for local use. Should the limited amount of water be used to produce food or energy? If energy-producing companies are able and willing to pay more than the farmers can for water, should this be permitted? Why or why not? Who has and/or should have the final say on such questions?

Ask a small group of students to assemble the strongest case they can in support of using water in the Great Plains for agriculture and other local needs. Ask another small group to prepare the best case they can to use the water for "national energy needs."

After the presentations, involve the class in assessing the strength of arguments presented by each side. Is the energy crisis so severe that either farmers or energy users must "lose" in this battle for limited water? What other options are available?

PURPOSE: To study the aesthetic value of wild and scenic rivers.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Art

CONCEPT: Water has recreational, aesthetic, cultural, and inspirational values which contribute to the quality of human life.

REFERENCE: Rivers Wild and Pure: A Priceless Legacy. National Geographic, v152 n1, July 1977, pp2-59.

In 1968, Congress passed the Wild and Scenic Rivers Act. Presently 19 rivers are covered by the Act. To qualify, the rivers must "possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values." Under the Act, rivers or sections of rivers are classified as either: 1) wild--unpolluted, undammed, with only primitive surroundings, accessible only by trails; 2) scenic--undammed, with shoreline largely undeveloped, accessible by road; or 3) recreational--readily accessible with some development and preexisting dams allowed.

Many people in the United States believe the need for flood control and hydroelectric power to be greater than scenic beauty. Although 50,000 dams now restrain U.S. rivers, the U.S. Army Corps of Engineers estimate that only about 38% of all sites with hydroelectric potential in the United States have been dammed.

ACTIVITY: Have students research the efforts to preserve wild and scenic rivers in America. (The article cited above includes a detailed map of those rivers presently protected by the Wild and Scenic Rivers Act.)

Does the beauty of a wild or scenic river compare with the advantages of flood control or electricity produced by non-polluting generating plants? How can the failure to build hydroelectric power sites be justified in an energy-hungry America? What can the natural rivers provide that money cannot buy?

PURPOSE: To provide students with an awareness of considerations which must be made in planning a nature study area.

LEVEL: Junior-senior high school

SUBJECT: Social Studies
Mathematics
Art

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: A Multidisciplinary Process Curriculum in Environmental Education, Grade 5. Edmonds School District 15, Lynnwood, Washington, 1973. ERIC: ED 099 220

ACTIVITY: Locate an unimproved or wooded area with a stream passing through it. Obtain permission from the owner of the land to survey the area. Have students measure the size of the land area, size of the stream, and note the location and sizes of trees, the elevation of the land, and any other unique features of the area.

Have each student or group of students make a scale drawing of the area and include on the map the locations of trees and streams. With the idea of making the area a nature center, have the students propose the locations of trails, benches, bridges, picnic tables, etc. by marking them on their maps. A variety of ideas for the area could be proposed (nature trail, picnic area, ampitheater) and shown on each group's plans for a particular use of the land.

In addition, each group could propose guidelines as to the number of people who could use the facility and rules regarding use of the facility. Would their proposal change the ecology of the area? How might the aquatic life in the stream be affected? What measures would be undertaken to insure that the nature area would not become a worn-out playground?

PURPOSE: To provide an example of environmental and economic considerations involved in water management decisions.

LEVEL: Junior-senior high school

SUBJECT: Language Arts
Social Studies
Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

REFERENCE: Water Quality Unit. Edmonds School District 15, Lynnwood, Washington, 1974. ERIC: ED 099 237

ACTIVITY: Prepare multiple copies of the situation and role cards. Each person should have a role card. If the group is large, those students who do not have presentations to make may be on the County Board of Commissioners. Each group (role) can be limited in their time of presentation. Following presentations, the Board can vote to close the water shed, leave the watershed open, or some compromise of the positions.

* * *

SITUATION CARD

SITUATION CARD

A proposal has been presented to the county Commissioners by the Water District to close the largest district watershed to access by any people except Water District personnel for operating purposes.

You, as an interested citizen with a definite interest as stated on your Role Card, either support or disagree with the move by the Water District.

Whether you agree or disagree with the ideas stated on your Role Card, or the views of the group you represent, you are to plan an argument to present to the County Board of Commissioners defending these views.

ROLE CARDS

LOCAL WATER DISTRICT MANAGER 1 Person

1. Recognizes benefits of more easily maintaining a quality water supply for patrons.
2. Having problems now with intruders (littering, potential forest fire danger, lake pollution, and vandals).

ENVIRONMENTALIST 5 people
(Sierra Club or other)

1. Close the watershed to all motors and motorized vehicles but allow foot travel beyond the outer boundaries.
2. By allowing only foot travel, it would allow area to be returned to a naturally balanced environmentally sound condition.

AMERICAN CANOE ASSOCIATION 3 people

1. Would close off many miles of good canoeing streams and lakes.
2. Canoeing is compatible with watershed uses - no pollution, oil, noise, etc.
3. Canoe campers are generally responsible outdoorsmen - don't leave litter, etc.

SPORTSMAN 3-5 people

1. Doesn't want streams and lakes closed because of recreational value.
2. Man is essential to an area of this type because if he were not present natural resources would be wasted.
3. Other points.

ROLE CARDS, Continued

LOCAL RESIDENTS DESIRING TO HAVE WATER SHED LEFT OPEN 5 people

Farmer - Wants to use the range land within the watershed

LOCAL RESIDENT DESIRING TO HAVE WATER SHED LEFT OPEN 5 people

Resident - Enjoys being away from city because of peace and quiet in a wooded surrounding.

LOCAL RESIDENTS DESIRING TO HAVE WATER SHED LEFT OPEN 5 people

City Merchant - Is a restaurant owner with business located near access route to watershed.

LOCAL RESIDENTS DESIRING TO HAVE WATER SHED LEFT OPEN 5 people

Local Citizen - Environmentalist. Lives quite far into the reserve and needs to drive to get to his home.

LOCAL RESIDENTS DESIRING TO HAVE WATER SHED LEFT OPEN 5 people

Caretaker - Takes care of a lake within the watershed. He can see how people use this area, but still has his own feelings as well as those of his department to contend with.

ROLE CARDS, Continued

LOCAL GOVERNING BOARD - COUNTY

1. Must run county for both health and satisfaction of all members as well as their safety.

2. Operate under a manual of regulations for county boards.

PURPOSE: To become aware of chemical pollution of water supplies.

LEVEL: Senior high school

SUBJECT: Science

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: National Wildlife, February-March 1977.

ACTIVITY: Review with the class the historically recent development by the chemical industry of new pesticides and other toxic substances that are known or highly suspected carcinogenic substances.

Assign a student or small team to investigate through library research recent examples of chemical pollution of water such as occurred at the Kepone plant in Hopewell, Virginia, that polluted the James River and subsequently Chesapeake Bay. Contamination by PCBs-poly-chlorinated biphenyls of water supplies in Michigan and elsewhere has also received considerable publicity as did an earlier mercury compound pollution of fishing waters in Japan. After short reports from students to the class on their findings, examine in general class discussion questions such as the following: How did we, as intelligent human beings, ever reach the present condition where dangerous chemical pollution of waters can occur? What can/should be done about such conditions? Are student suggestions "practical"? Who should decide whether the suggestions are practical or not?

PURPOSE: To determine the sources of water entering and leaving a water system.

LEVEL: Senior high school

SUBJECT: Science

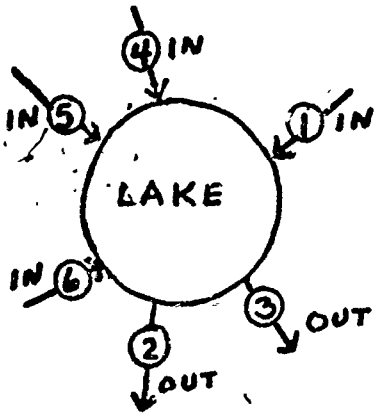
CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

REFERENCE: Mason, Fred J., and Joseph F. Houdart. Water Quality Monitoring Manual. Whitesbog, New Jersey: Conservation and Environmental Studies Center, 1970. ERIC: ED 45 392

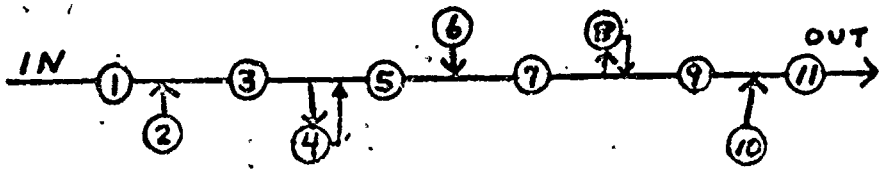
You may choose to accompany a pond or stream study with this activity.

ACTIVITY: Before analysis of a water system (pond, lake, stream, bay, river, bayou or reservoir) is made, the sources of water coming into the system should be located. Some flowing bodies of water may show wide-ranging disparity in pollution tests due to effluents.

If a large area is to be studied, maps or charts available from local, county, or state agencies may be helpful. In a city, the stream might be walked to find the various input points. Once the inputs and outputs (areas in which water flows out from the major body of water) are located, they may be mapped. Typical maps could look like these:



FOR A LAKE



FOR A STREAM

Assignment of the number order is arbitrary. In water testing exercises, samples should be analyzed at each location in which water goes into or out of the system.

PURPOSE: To examine technologies available to desalt seawater.

LEVEL: Senior high school

SUBJECT: Science

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: The Christian Science Monitor, March 24, 1977.

An article by Brad Knickerbocker in the reference cited above reports that chemist Hugh H. Sephton at the University of California's seawater conversion laboratory near San Francisco has developed a technique which can reduce by 25 to 50 percent the energy needed to purify seawater by distillation. "By adding a very small amount of biodegradable detergent to seawater, the rate of evaporation can be doubled."

ACTIVITY: In a chemistry or physical science laboratory, involve students in planning a series of experiments to verify the results reported by chemist Sephton. Plan to use two or three different detergents. Plan to vary "the very small amount" of detergent used. Plan to standardize factors such as amount of seawater used and timing procedures. Share findings and account for results.

Assign three students or student teams to investigate science and/or engineering literature to ascertain the status of developments, worldwide, to desalinate water by distillation, reverse osmosis, and freezing, and report to the class. Should we develop such projects, or stress water conservation, or both? Which strategy is most economical?

PURPOSE: To examine the possibility of electrical production from the use of ocean temperature differentials.

LEVEL: Senior high school

SUBJECT: Science

CONCEPT: In water management, as well as in other environmental concerns, choices must often be made. People should have the necessary knowledge to understand the issues and make wise decisions on them.

REFERENCE: Walker, Harry O. Energy: Options and Issues. Davis, California: The University of California, 1977.

Visualize the oceans, which cover 72% of the earth, as an immense solar energy collector and storage unit. This energy, represented by the water temperature, holds tremendous potential for energy utilization. Around the globe, water temperatures usually decrease at lower depths. The maximum temperature differential exists in equatorial regions where ocean surface temperatures may range from 80°F. at the surface to 40°F. at depths of a thousand meters.

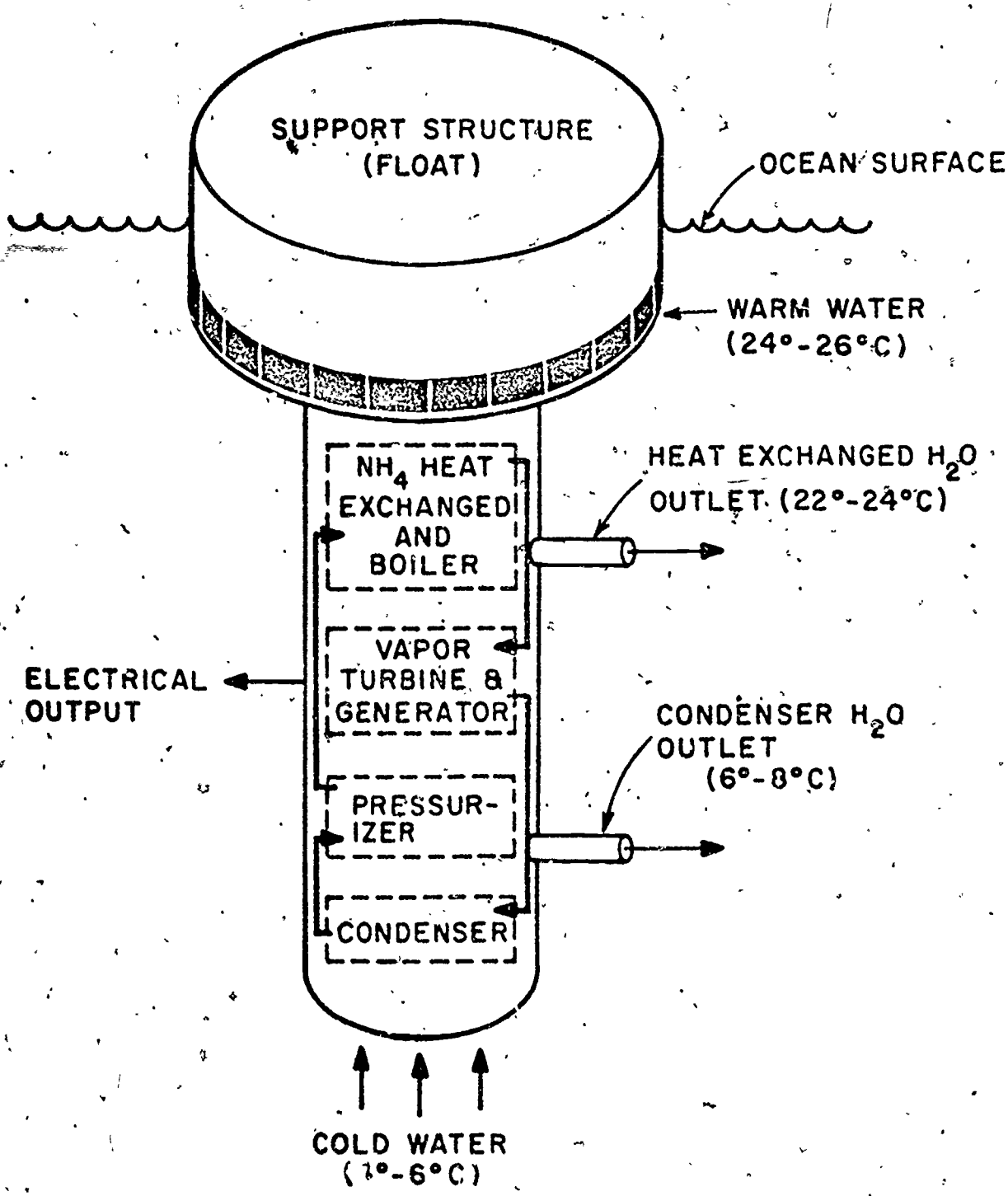
With this differential, low temperature heat-engines may be a feasible way to convert the ocean's heat energy to electrical energy. A schematic of a thermal gradient generating unit is shown below. In ocean thermal units, solar heat energy, stored in surface water, would be utilized to vaporize a working fluid such as propane. The vaporized fluid would pass through a turbine-generating unit, be condensed in a cooling coil exposed to low temperature ocean water and recycled.

Since the equatorial regions offer the greatest temperature gradient, these areas and related places such as the Gulf Stream current are most suitable for this device. An extended water intake of several hundred meters in length might be needed. In addition, protection against tropical storms and transmission of power would have to be achieved.

At the present time, few environmental concerns over the operation of the device has not been used extensively, however, so the environmental impact may not yet be known.

ACTIVITY: What are some of the reasons that the device has not received much attention in the United States as a potential source of electricity?

What factors may change this in the future?



Ocean thermal gradient generating unit schematic.

PURPOSE: To examine water pollution from agricultural land.

LEVEL: Senior high school

SUBJECT: Science
Social Studies

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

Review with the class the enormous increase of chemical fertilizers, herbicides, and pesticides being used in American truck farming and agriculture generally. A substantial portion of the heavy applications of these substances placed on plants and/or the surface of the soil is often washed away by rain into streams and subsequently into rivers or lakes which serve as the water supply for large cities. Many of these substances dissolve readily in water and they are not removed by the processes used to purify city water supplies. The long-term effect of these dissolved ingested substances on man's health is not clearly known; evidence collected to date, however, is worrisome to some health scientists.

ACTIVITY: Ask a small group of students to examine this problem through the eyes of farmers, county extension agents, and agri-business personnel who make or sell fertilizers, pesticides, and herbicides. Do they see this as a real or imaginary problem? What precautions do they take to minimize the likelihood of harm from the use of these chemicals?

Simultaneously, ask another small group to examine the problem through the eyes of persons such as organic gardeners, "friends of the earth," or others who are objecting to the use of such chemicals on the land. What evidence can they offer to justify their concerns? How can they justify reductions in agricultural output when there is a present or predicted shortage of food in the world?

Ask each group to report their findings to the class. Follow the presentations with class discussion to define areas of agreement or disagreement. What, if anything, can/should be done by the various constituencies concerned with this problem?

PURPOSE: To study the physical aspects of water pollution.

LEVEL: Senior high school

SUBJECT: Science
Art
Mathematics

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Murphy, James E: Water Pollution. Part 3. Physical Aspects. Science Activities, March, 1972, pp30-35.

A study of the physical aspects of water pollution can find relevance in either biology classes, introductory chemistry, physics, or physical science. Many principles used in the work are adapted from physics or chemistry, and applied to an ecological setting.

Because this study is based on the analysis of polluted water, cities are equally suitable sites with streams or ponds in rural settings. Bridges or docks make ideal sampling stations. The actual approach to the study will depend upon local conditions. A single group visit to one site will produce a wealth of information, or students may bring water samples to the classroom. In the latter example, although large distribution of samples are collected, there are limitations on the emical tests that can be run.

If a field trip is used, safety and supervision are essential. Also, it is important that the field work be organized so that every student has something to do, and the directions as well as the objectives of the study should be clearly defined.

ACTIVITY: If a field trip is used, forms such as the "Water Data Card" may be prepared. Students can be divided into teams with each group being responsible for measurements at a specific location.

Collection of the water sample: Water samples can be collected by using a large variety of commercial devices. For this piece of apparatus, an inexpensive alternative device can be constructed. (See activity describing the construction of a water sampler.) If time allows, samples should be collected at several areas and depth intervals of five feet--including the surface and the bottom.

Analysis of the water sample:

1. Temperature - any standard thermometer is fine.
2. pH - use pH paper
3. Dissolved oxygen - use procedure of water testing kit or refer to Murphy's article.
4. Dissolved CO_2 - see #3
5. Alkalinity - see #3

6. Current - use stopwatch, floating wood, and pre-measured distance. Recall velocity = distance/time.

7. Specific gravity - use of hydrometer with water samples. Distilled water gives reading of 1.00; large amounts of organic liquids will lower the reading.

8. Water color - see #3.

9. Odor - qualititative description by student.

10. Secchi reading - for construction of a Secchi Disk, see Activity on Secchi Disks. To use a Secchi Disk, lower it into the water until it drops out of sight. Record this distance as well as the depth at which it reappears when it is drawn up. The average of the two measurements is a measure of the depth of light penetration.

Depending on the number and accuracy of the data collected, any number of the following summary questions and problems may be attempted.

1. Draw a scale cross-sectional profile of the study area, and use contour lines to show thermal gradients, O_2 and CO_2 concentrations, line penetration, pH and alkalinity levels, and the nature of the bottom materials.

2. How does the contour affect the current and vice-versa?

3. What specific factors have the greatest effect on the current?

4. Explain what causes any thermal gradient you found. Will this affect any other physical characteristics of the water?

5. How does current or lack of it affect the chemical composition?

6. What factors restrict light penetration?

7. What sources of pollution exist and how do they affect the chemical and physical aspects of the water?

8. What practical measures could be undertakent to stop pollution where the sample is taken?

9. Describe what you consider to be any major errors in the data you collected for this study and tell how these errors might be elminiated.

WATER DATA CARD

Location _____ Date _____ Group _____

Body of Water _____ Air Temperature _____ Weather _____

General Appearance of Water _____

General Appearance of Bottom of Waterway _____

Depth at which readings were taken:	Surface						Bottom
Temperature							
pH							
Dissolved Oxygen							
Dissolved Carbon Dioxide							
Alkalinity							
Current							
Specific Gravity							
Water Color							
Odor							
Secchi Reading							

Comments: _____

PURPOSE: To examine the importance of riverways as transportation arteries.

LEVEL: Senior high school

SUBJECT: Social Studies

CONCEPT: Water quality and availability directly affect the physical environment, health, and all human institutions and activities.

Rivers have been of enormous importance in the exploration, settlement, and development of the United States. George Washington, for example, used the Ohio River and its tributaries when he conducted land surveys in the Northwest Territory. Lewis and Clark used the Missouri and Columbia Rivers to assess, for Thomas Jefferson, the true scope of the Louisiana Purchase. Undoubtedly the Mississippi River was largely responsible for the early settlement and importance of New Orleans. Settlements such as Pittsburgh, Cincinnati, Minneapolis, St. Louis, Memphis, Omaha, and Portland became important cities, in large measure, as a result of their location on major navigable rivers.

River barges today carry enormous tonnages of raw materials and processed industrial goods. Substances such as coal, oil products, gravel, and chemicals constitute major portions of the freight carried on America's waterways.

ACTIVITY: Review with the class the little known fact that the locks and channels on U.S. rivers are built and maintained by the U.S. Army Corps of Engineers. These facilities are built with public tax monies, but the river barge lines pay nothing for their use. Some persons believe such an arrangement gives an unfair advantage to barge traffic while it discriminates against railroads or highway freight haulers.

Ask class members to collect opinions on this question with special effort to get judgments from persons who work for barge lines, railroads, and trucking firms. Discuss findings in class with an attempt to reach concensus or at least to clarify different positions.

PURPOSE: To examine a pollution problem in America's largest fresh water lake.

LEVEL: Senior high school

SUBJECT: Social Studies
Science

CONCEPT: Water is connected to everything else in nature. Therefore, it cannot be understood or managed as a separate entity, unrelated to the rest of the physical or human environment.

REFERENCE: Strahler, Arthur N., and Alan H. Strahler. Geography and Man's Environment. New York: John Wiley and Sons, 1977, pp118-120.

ACTIVITY: From the reference above or from other sources such as Science, v186, pp31-35, have a student or two investigate the pollution of Lake Superior by the Reserve Mining Company located in Silver Bay, Minnesota.

In their report to the class, urge that attention be given to questions such as the following:

Why could the company dump waste sludge into the lake for twenty years before being ordered to stop?

Why was action against the company initiated by citizens of Duluth (50 miles away) rather than by citizens of Silver Bay where the plant was located?

How does the company propose to dispose of the sludge now rather than dump it in the Lake? Why wasn't this method used earlier? Has it been common practice for Americans to use streams or lakes as dumping grounds? Why?

After the report, engage the class in discussion aimed at clarifying student attitudes toward governmental efforts to improve water quality in lakes and streams.

PURPOSE: To examine problems associated with flood control.

LEVEL: Senior high school

SUBJECT: Social Studies
Science

CONCEPT: There are limits to what water management can do to control the availability and quality of water.

Secure from a film library or film rental service the 29-minute motion picture "Planning for Floods", produced in 1974 by the Environmental Defense Fund. This film narrated by Hugh Downs points out how rivers in their natural state spread over flood plains, depositing rich soil suitable for agriculture. The film describes how levies and dams, built to permit construction of homes and industries on the flood plains have created super-floods, diverting water away from natural drainage patterns. The film depicts scenes of floods along the Mississippi River and in Rapid City, South Dakota which destroyed homes and industries with great loss of life and property. The film makes a powerful case for effecti flood plain management.

ACTIVITY: After viewing the film, divide the class into two groups. Instruct students in one group to present arguments against mandated flood plain zoning by states or larger political units, while students in the other group present the counter arguments. Group one should also present arguments for the present policy of low cost federally subsidized flood insurance available to persons who live in areas subjected to regular flooding, while the second group presents arguments objecting to this policy.

After hearing the arguments, ask each class member to vote on the two issues. Are they for or against mandated flood plain zoning? Are they in favor of eliminating federally subsidized flood insurance?

PURPOSE: To study the composition of seawater.

LEVEL: Senior high school

SUBJECT: Science
Mathematics

CONCEPT: Water has unique physical and chemical properties.

REFERENCE: Laboratory Experiences for Earth and Space Science. Arlington County Public Schools, Arlington, Virginia, 1965.

Some of the rainwater which falls to the earth is carried by streams to rivers and by rivers to the ocean. As the water passes over the land and into the streams, minerals dissolve in it. This dissolved mineral content, is carried into the oceans. Analysis of seawater divides the minerals into a class of compounds known as salts. In one million kilograms of seawater there are thirty-five thousand kilograms of salts.

The seven major salts in seawater are:

	Kg. per million Kg. of seawater
Sodium Chloride ($NaCl$)	27,213
Magnesium Chloride ($MgCl_2$)	3,807
Magnesium Sulfate ($MgSO_4$)	1,658
Calcium Sulfate ($CaSO_4$)	1,260
Potassium Sulfate (K_2SO_4)	863
Calcium Carbonate ($CaCO_3$)	123
Magnesium Bromide ($MgBr_2$)	76
Total	35,000

ACTIVITY: Provide students with information in the table above. Have students solve the following problems:

1. How many kg. of dissolved minerals are contained in 100 kg. of seawater? In 1 kg. of seawater?

2. Sodium chloride content of seawater is how many times that of magnesium chloride? Express your answer to the nearest tenth.

3. Sodium chloride content of seawater is how many times that of magnesium bromide? Round your answer to the nearest whole number.

4. If you wanted to mine 7,614 kg. of magnesium chloride from seawater, how many kg. of seawater would you have to process if you could get all of the magnesium chloride out of each kg. of water?

5. Of the seven salts, how many are classified as metallic salts? List them.

TEACHING RESOURCES

TEACHING RESOURCES

FILMS

The following films may be useful in providing audio-visual supplementation to water-related activities. All of the films are 16mm. and are arranged alphabetically by title, followed by distributor, release date, and running time. The predominant theme or concepts advanced in the film are listed. Addresses of distributors are included at the end of the film list. In addition, the interest level(s) is given following each entry:

p	=	primary
el	=	elementary
jh	=	junior high
sh	=	senior high
c(i)	=	introductory college
c	=	college
g	=	general

Those films followed by (EGFF) are included in the Educator's Guide to Free Films and may be obtained from the distributor by writing the request on official school stationery and mentioning the Educator's Guide. Requests should be made by school administrators, teachers, or librarians--not students. The request date should be made at least one month prior to the desired showing date and two alternate dates should be provided.

This list is not intended to present an exhaustive examination of films on water-related studies. Several excellent film bibliographies exist. Among them are:

Project Coast. Audio-Visual Aids, Games, and Art for Marine Environment Studies. University of Delaware, Sea Grant Program, 1977.

Canadian National Committee. Water Films, 2nd Edition, 1965-1974. U.S. Office of Education, 1970. ERIC: ED 067 224

Chapman, Frank L. Marine Science Film Catalog, Movies, Filmstrips, and Slides. U.S. Office of Education, 1967. ERIC: ED 019 252

Films

The Case Against Chicken Little (Modern Talking Picture Service) (EGFF)
Water pollution by paper mills.
jh-sh — 15 min. Color

Cry of the Marsh (ACI) 1969.
Destruction of marsh in name of progress.
el-jh-sh — 12 min. Color

Deep Blue World (Pyramid) 1973.
Depicts marine life.
el-jh-sh-c-g — 7 min. Color

The Deep Frontier (Modern Talking Picture Service - 21st Century CBS) (EGFF) 1970.
Describes projects and shows deep sea equipment.
jh-sh-c(i)-g — 30 min. Color

Delaware River Model (U.S. Army Corps of Engineers) c. 1958.
Model of Delaware River.
sh-c — 6 min. B & W

Deterioration of Water (Learning Corporation of America) 1972.
Pollution, eutrophication.
jh-sh-c(i)-g — 20 min. Color

Dockside (Churchill) 1973.
Activities of a port.
el-jh — 15 min. Color

Draggerman's Haul (Filmfair) 1975.
Fisherman's life.
jh-sh — 18 min. Color

Drop by Drop to the Sea (Q-ED Productions) 1973.
Oceans as a source of food, oxygen.
jh-sh-g — 22 min. Color

The Drowning Bay (King)
Near destruction of San Francisco Bay
el — 9 min. Color

The Earth: Coastlines (Coronet) 1970.
Creation of beaches.
jh-sh — 11 min. Color

The Earth: Its Oceans (Coronet) 1960.
Explains currents, sediments, tides.
el-jh — 12-1/2 min. Color

Ecology: A Community Beneath the Sea (BFA) 1971.
Interactions within a community.
el-jh — 9-1/2 min. Color

The Endangered Shore (Delaware Wild Lands) 1972.
Pollution, decision making.
el-jh-sh-c-g — 14 min. Color

The Endless Sea (Learning Corp. of America) 1971.
Pollution, water cycle, other marine related topics.
jh-sh-c(i)-g — 28 min. Color

The Erie Canal (BFA) 1968.
Construction of canal.
jh-sh-g — 17 min. Color

Estuarine Heritage (NOAA) 1969.
Importance of estuaries, pollution.
jh-sh — 28 min. Color

Estuary (NOAA) 1976.
Effects of pollution on estuaries.
el-jh-sh-g — Approx. 22 min. Color

The Everglades (Films, Inc.) 1971.
Effects of pollution.
jh-sh-c-g — 28 min. Color

Exploring the Oceans (Churchill) 1973.
Introduction to oceanography.
el — 13 min. Color

The Gifts (Modern Talking Picture Service) (EGFF) 1965.
Importance of water.
jh-sh — 28 min. Color

Gulf Stream (Department of Navy) (EGFF) 1971.
Study of the gulf stream.
jh-sh-c(i)-g — 28 min. Color

Harbors of America (Telefilm/Mercury Outboard) c. 1965.
History.
jh-sh-g — 28 min. Color

How's the Water? (Johnson Outboards/Florida Dept. of Commerce) (EGFF) 1972.
Pollution, development.
jh-sh-g — 21 min. Color

Inland Waterways, Inland Ports (Arthur Barr) 1973.
Trade, commerce.
el-jh — 15 min. Color

An Introduction to Coastal Engineering (U.S. Army Corps of Engineers-L.A) c. 1965.
Pro-development of harbors, coasts.
sh-c-g — 15 min. Color

It's Your Coast (NOAA) c. 1973.
Decision making.
jh-sh-c-g — 28 min. Color

It's Your Decision--Clean Water (Regional Film Center) (EGFF) 1954.
Sewage treatment.
jh-sh-g — 14-1/2 min. Color

The Land of the Drowned River (AV-Exploration) c. 1969.
Marine life of swamps.
el-sh-g — 23 min. Color

Land of the Sea (Modern Talking Picture Service) (EGFF) 1967.
Oceanographic research.
jh-sh-c(i)-g — 25 min. Color

The Last Marsh (Films, Inc.) 1972.
Effects of pollution on marsh.
jh-sh-g — 10 min. Color

Men at Bay (King) 1970.
Story of near destruction of San Francisco Bay
jh-sh-c-g — 26 min. Color

Men, Ships, and Great Lakes (U.S. Corps of Engineers) c. 1959.
el-jh-sh — 26 min. Color

Nature of Sea Water (Dept. of the Navy) (EGFF) 1967.
Physical properties of sea water.
jh-sh — 29 min. Color

North America--Its Coastlines (Coronet) 1972.
Geography oriented.
el-jh — 13-1/2 min. Color

The Ocean: A First Film (BFA) 1968.
Sea life.
el — 11 min. Color

Oil! Spo! ! (Sierra Club) 1971.
Appe.. against oil pollution.
el-jh-sh-c-g — 16 min. Color

Our Round Earth--Its Waters (Coronet) 1971.
Introductory film on water cycle.
el — 11 min. Color

Paddle to the Sea (McGraw-Hill) c. 1967.
Based on book of same name.
31 — 28 min. Color

Plankton (National Geographic) 1976.
Food webs.
jh-sh-c(i)-g — 12 min. Color

Planning for a Better Bay (U.S. Army Corps of Engineers, Baltimore) c. 1974.
Interelatedness, decision making.
jh-sh — 22 min. Color

Planning for Floods (Environmental Defense Fund Assn.-Sterling Films) 1974.
Examines dangers of building on flood plairs and restricting rivers.
jh-sh 29 min. Color

The Poisoned Sea (Moonlight Productions) 1973.
Pollution.
jh-sh-c-g 27 min. Color

Pond Life Food Web (National Geographic) 1976.
Ecological understanding.
jh-sh-g 10 min. Color

Renaissance of a River (Interstate Advisory Committee on the Susquehanna) (EGFF) 1965.
Water clean-up.
jh-sh-g 22 min. Color

The Rise and Fall of the Great Lakes (Pyramid) 1961.
Rebirth of Great Lakes.
jh-sh-c-g 18 min. Color

Santa Barbara--Everybody's Mistake (Indiana University) 1970.
Oil pollution.
jh-sh-c-g 30 min. Color

Second Chance (Pyramid) 1976.
Ocean sea life depletion, decision making.
el-jh 11 min. Color

Should Oceans Meet? (Time-Life) c. 1970.
Ecological effect of Atlantic-Pacific canal.
jh-sh-c(i)-g 30 min. Color

Steamboat Bill (BFA) 1971.
History of steamboat captain.
el 11 min. Color

Tidal Power (U.S. Army Corps of Engineers Waterways) c. 1964.
Tidal project on Passamaquoddy Bay explained.
jh-sh-c-g 25 min. Color

Water Bill, U.S.A. (Modern Talking Picture Service) (EGFF) 1965.
Conservation.
sh-c(i)-g 27 min. Color

Waterbound, Our Changing Outer Banks (Cinemascnics) c. 1974.
History, Carolina Outer Banks.
jh-sh-c-g 18 min. Color

The Water Planet (Churchill) c. 1970.
Interelatedness.
jh-sh-g — 19 min. Color

Wetlands of the U.S.A. (Macmillan) 1972.
Swamp areas.
jh-sh-g — 12 min. Color

Wild River (Modern Talking Picture Service) (EGFF)
Protection of water sources.
sh-c(i)-g — 13 min. Color

The Year of Disaster (Caterpillar Dealers and Caterpillar Advertising Division) (EGFF)
Water shortage.
sh-c(i)-g — 28 min. Color

ADDRESSES OF FILM DISTRIBUTORS

ACI Productions
11th Floor
35 W. 45th Street
New York, NY 10036

Arthur Barr Productions, Inc.
P.O. Box 7-G
Pasadena, CA 91104

Association-Sterling Films
600 Grand Avenue
Ridgefield, NJ 07657

A-V Explorations, Inc.
2000 Eggert Road
Amherst- NY 14226

BFA Educational Media
467 Severna Drive
Severna Park, MD 21146

Caterpillar Dealers and Caterpillar
Advertising Division
Peoria, IL 61602

Churchill Films
622 North Robertson Boulevard
Los Angeles, CA 90069

Cinemasonics
CPT Film Laboratory
639 Wellons Village
Durham, NC 2-703
(WATERBOUND must be ordered
through University of North Carolina
Sea Grant College Program, Attention:
Dr. W. L. Rickards, 1235 Burlington
Labs., North Carolina State University,
Raleigh, NC 27607.)

Coronet Instructional Media
65 East South Water Street
Chicago, IL 60601

Delaware Wild Lands, Inc.
5806 Kennett Pike
Centerville, DE 19807

Department of the Navy
Naval Education and Training Support
Center
Atlantic Commanding Officer
Naval Station, Bldg. Z-86
Norfolk, VA 23511

Filmfair Communications
10900 Ventura Boulevard
Studio City, CA 91604

Films, Inc.
Director of Distribution
1150 Wilmette Avenue
Wilmette, IL 60091

Indiana University
Audio-Visual Center
Bloomington, IN 41401

Interstate Advisory Committee on
the Susquehanna
2101 North Front Street
Harrisburg, PA 17110

Johnson Outboards
Distributed by:
Florida Department of Commerce
Film Library
Collins Building
107 West Gaines Street
Tallahassee, FL 32304

King Screen Productions
320 Aurora Avenue, North
Seattle, WA 98109

Learning Corp. of America
5065 Berwyn Road
College Park, MD 20740

Macmillan Films
34 MacQuesten Parkway So.
Mt. Vernon, NY 10550

McGraw-Hill Text Films
330 West 4snd Street
New York, NY 10036

Modern Talking Picture Service
2323 New Hyde Park Road
New Hyde Park, NY 11040

Moonlight Productions
2650 California Street
Mountain View, CA 94040

Movies U.S.A., Inc.
Operations Center
46 West 61st Street
New York, NY 10023

National Geographic Films
Distributed by:
Modern Talking Picture Service

NOAA
Motion Picture Service
Department of Commerce
12231 Wilkins Avenue
Rockville, MD 20852

Pyramid Film Productions
P.O. Box 1048
317 Georgina Avenue
Santa Monica, CA 90406

Q-ED Productions
P.O. Box 1608
Burbank, CA 91507

Regional Film Center
600 Grand Avenue
Ridgefield, NJ 07657

Telefilm Ltd.
P.O. Box 709
Homosassa Springs, FL 32647

Time-Life Films
100 Eisenhower Drive
Paramus, NJ 07652

U.S. Army Corps of Engineers
District Baltimore
P.O. Box 1715
Baltimore, MD 21203

U.S. Army Corps of Engineers District
Los Angeles
Attn: Graphic Arts (Rm. 6213)
P.O. Box 2711
Los Angeles, CA 90053

U.S. Army Corps of Engineers
Waterways Experimental Station
P.O. Box 631
Vicksburg, MS 39180

FILMSTRIPS

The filmstrips listed were selected because of their relevance to the water activities included in this publication. The sources are listed as they appeared in the catalogs used; some of the filmstrips may be available from other sources. Cassettes are included where the notation "sound" is used.

The Aquarium. McGraw-Hill. 42 frames. Color. Gr. level 1-6.

The Beach. Prentice-Hall. Sound. Color. Gr. Level 5-12.

Different Kinds of Animals: Some Water Animals. Encyclopedia Britannica. 38 frames. Color. Gr. level 1-3.

Ecology: Pollution. Prentice-Hall. Sound. Color. Gr. level 5-12.
Series of two:
- Pollution of the Atmosphere
- Pollution of the Waters

Oceans and Coasts. McGraw-Hill. 40 frames. Color. Gr. level 4-8.

Seacoast Ecology. McGraw-Hill. 48 frames. Gr. level 7-12.

Shores: The Edges of Things. Prentice-Hall. Sound. Color. Gr. level 4-8.
Series of six:
- Our Shores
- Patterns of Rocky Shores
- Inhabitants
- Beaches and Their Sand
- Marshes and Their Mud
- Wind and Sand

Water for Tomorrow. KDI Instructional Systems, Inc., Columbus, Ohio 43220.

Water Pollution. Prentice-Hall. Sound. Color. Gr. level 6-8.

The Wetlands. Prentice-Hall. Sound. Color. Gr. level 5-12.
Series of two:
- Salt Water
- Fresh Water

1971 EQ Index. National Wildlife Federation.

WATER TESTING EQUIPMENT

Reference: A Curriculum Activities Guide to Water Pollution Equipment and Environmental Studies, Volume 3. Institute for Environmental Education, Cleveland, Ohio, 1973. ERIC: Ed 093 648.

For many tests, the water testing equipment need not be elaborate. A portion of this activity book contains construction information for simple water-testing apparatus. The testing of some parameters, particularly in the chemical and biological realms lie beyond the capabilities of these instruments. Accordingly, a list of water equipment suppliers and manufacturers is provided. Prices and product information are available from these sources.

Manufacturer	Address	Remarks
Bridge Mail Division (617) 923-1020	Watertown, MA 02172	Kits, equipment
Hach Chemical Co. (515) 232-2533	Box 907, Ames, IA 50010	Kits, reagents
Koslow Scientific Co. (201) 861-2266	7800 River Road North Bergen, NJ 07047	Kits, heavy metals
LaMotte Chemical Products Co. (301) 778-3100	Chestertown, MD 21620	Excellent kits and literature
Millipore Corp. (617) 275-9200	Bedford, MA 01730	Excellent bacteriology equipment & literature
Novo Enzyme Corp. (914) 698-7001	1030 Mamaroneck Ave. Mamaroneck, NY 10543	Enzyme experiments, kits
Oceanography Unlimited (201) 779-2313	108 Main Street Lodi, NJ 07664	Kits, equipment
Wildlife Supply Co. (517) 799-8100	Saginaw, MI 48602	Quality field equipment

Supplier	Address	Remarks
American Chemical Society (202) 737-3337	1155 16th St., N.W. Washington, DC 20036	Lab guide - catalogue of catalogues
Beckman Instruments, Inc (714) 871-4848	2500 Harbor Blvd. Fullerton, CA 92632	High quality lab equipment
Carolina Biological Supply Co. (919) 584-3771	Burlington, NC 27215	Specimens, AV equipment

Supplier	Address	Remarks
Central Scientific Co. (312) 677-8300	2600 S. Kostner Ave. Chicago, IL 60623	Broad line, good service
Damon Corp. (617) 449-0800	115 Fourth Ave. Needham Hts., MA 02194	ESCP, Kits
Eduquip, Inc. (617) 298-0160.	1220 Adams St. Boston, MA 02129	Supplies from other manufacturers, kits
Fisher Scientific Co. (412) 592-8300	711 Forbes AVe. Pittsburgh, PA 19219	Broad line
Forestry Suppliers, Inc. (601) 359-3569	Box 8397 Jackson, MS 39204	Broad line
Jewel Industries (312) 622-6622	9005 W. Armitage Ave. Chicago, IL 60630	Aquaria-terraria
Macalaster Scientific Co. (603) 883-4151	Nashua, NH 03060	Broad line
Minnesota Environmental Science Fdn., Inc. (612) 544-8971	5400 Glenwood Ave. Minneapolis, MN 99422	Excellent activities
NASCO (414) 563-2446	901 Janesville Ave. Fort Atkinson, WI 53638	Broad line
National Wildlife Fed. (202) 483-1950	1412 16th St., N.W. Washington, DC 20036	Literature, booklets
Northeast Marine Specimens Co. (617) 799-4099	P.O. Box 1 Woods Hole, MA 02543	Marine specimens
Sargent-Welch Scientific Co. (312) 677-0600	7300 North Linder Skokie, IL 60076	Broad line
Science Kits, Inc. (716) 874-6020	777 E. Park DR. Towanda, NY 16150	Kits
Scott Scientific (303) 484-4706	P.O. Box 2121 Fort Collins, CO 80921	Kits, activities
Turtox/Cambusco (312) 488-4100	8200 S. Hoyne Ave. Chicago, IL 60620	Broad line
Wards' Natural Science Establishment, Inc. (716) 467-8400	P.O. Box 1712 Rochester, NY 14603	Specimens, equipment